S. HRG. 101-671

NATIONAL ENERGY POLICY ACT OF 1989 AND FEDERAL ENERGY MANAGEMENT AMENDMENTS OF 1990

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

SECOND SESSION

ON

S. 324

TO ESTABLISH A NATIONAL ENERGY POLICY TO REDUCE GLOBAL WARMING, AND FOR OTHER PURPOSES

AND

S. 2191

TO AMEND PART 3, TITLE V, OF THE NATIONAL ENERGY CONSERVATION POLICY ACT

APRIL 5, 1990

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S311-36

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NATIONAL ENERGY POLICY ACT OF 1989 AND FEDERAL ENERGY MANAGEMENT AMENDMENTS OF 1990

THURSDAY, APRIL 5, 1990

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 9:35 a.m. in Room SD-366, Dirksen Senate Office Building, Hon. J. Bennett Johnston, chairman, presiding.

OPENING STATEMENT OF HON. TIMOTHY E. WIRTH, U.S. SENATOR FROM COLORADO

Senator WIRTH [presiding]. The committee could come to order. Senator Johnston will be here very shortly and asked if we might get going.

I want to again thank the Chairman for calling this hearing on S. 324, the National Energy Policy Act of 1989. During the past three years this Committee has held many days of hearings on the issue of global warming. We have called close to 50 witnesses about the subject and about the legislation before us.

At the most dramatic hearing to date on this issue Chairman Johnston told this Committee that, "We have got only one planet. If we screw it up, we have nowhere else to go."

During the last 18 months the evidence that we are fundamentally altering the atmosphere has only become more clear, and the truth of the Chairman's statement is also more clear today than it was a short 18 months ago. We are irresponsibly fooling around with Mother Nature, and it is time to change our course.

In this process I hope we will receive the support of the Administration. In discussing the greenhouse effect (during the 1988 campaign) then-Vice President Bush stated that when elected, the American public would see the White House effect. Unfortunately, as has been stated over and over, we have seen more of the whitewash effect.

I hope this pattern changes. I have been encouraged by some of the press reports of the Department of Energy's energy policy review and hope that constructive steps will be outlined in the Department's testimony this morning.

Since I introduced this legislation almost two years ago, I have been very pleased to work very closely with the Chairman of the Committee and the distinguished ranking member. We have

worked together and have negotiated what I think is a responsible, albeit modest, compromise.

The joint staff agreement is a road map not a mandate for the future. This bill begins the process of evaluating how our energy policy is going to contribute to reducing greenhouse gas emissions, and that goal does not come from me or from the Committee. That goal comes from this Administration and the declaration it signed last fall in the Netherlands.

The legislation before us initiates some important planning procedures that must be adopted in the light of evidence about global warming. Further, this legislation would move the United States in the direction of energy efficiency initiatives that make sense for many reasons independent of our concern for global warming.

On the research and development side, I believe this legislation encourages research programs that make sense for a number of reasons, not the least of which is our growing dependence on foreign oil.

In summary, this legislation has been a long time in coming. We have held painfully laborious and extensive hearings. We know the risks, and we know what we ought to be doing.

The Committee cannot make the mistake of being outside the mainstream of the issue. The evidence appears to be overwhelming. The issue is no longer if the globe is warming but how much, how fast.

I want to again thank and praise the Chairman of the Committee, Chairman Johnston, for his leadership on this issue as well as that of Senator McClure and his staff for the cooperative spirit they have exhibited in crafting the legislation. I hope that we will move swiftly to mark up the legislation.

Our first witness this morning is the distinguished junior Senator from the state of Connecticut who brings a deep commitment in the area of energy policy and the environment, and we have been joined by the distinguished junior Senator from the great state of West Virginia, Senator Rockefeller. Delighted to have you here.

Senator ROCKEFELLER. I have a statement to enter into the record.

Senator WIRTH. It will be included in the record in full.

Senator ROCKEFELLER. Thank you.

[The prepared statements of Senators Johnston, McClure, Rockefeller and Matsunaga and the staff draft follow:]

Statement of J. Bennett Johnston

Hearing to Receive Testimony on
the Joint Staff Amendment of the Substitute to S. 324
the National Energy Policy Act of 1990

I am pleased to welcome you to this morning's hearing on the joint staff amendment in the nature of a substitute to S. 324, the National Energy Policy Act of 1990. The Committee looks forward to receiving the views of invited witnesses from the Department of Energy and the White House Office of Science and Technology Policy, as well as my colleague, Senator Lieberman. Dr. Bromley, we are especially interested to hear your testimony on the state of the science regarding global climate change, as there seems to be a great deal of debate surrounding the exact pace and degree of global climate change.

The legislation to be discussed this morning, represents a joint Committee effort to draft a comprehensive national energy policy to stabilize the generation of carbon dioxide and greenhouse gases as quickly as is technically and economically feasible. The bill focuses on least-cost planning, energy efficiency, innovative renewable energy technologies, and energy technology transfer. These are all policies that are worth pursuing in and of themselves. The fact that these policies would also reduce emissions of carbon dioxide and greenhouse gases is simply an extra bonus.

The completion of the joint staff amendment coincides with this week's release of DOE's National Energy Strategy Interim Report. Secretary Watkins stated publicly that he has placed seven options from the NES on a "fast-track" and assigned them to an interagency working group under the chairmanship of Henson Moore. The Committee is pleased that six of these critical goals are currently reflected in the joint staff substitute amendment. These are:

* integrated resource planning;
* enhanced energy efficiency;
* increased use of renewables;
* streamlined technology transfer;
* modeling the US energy economy; and
* pollution prevention.

When President Bush first initiated the National Energy Strategy in July of 1989, he stated that "...our bipartisan task is to build the national consensus necessary to support this strategy and to make this strategy a living and dynamic document responsive to new knowledge and new ideas...". I believe that S. 324 will help to further the process of building a national energy strategy while taking into consideration the threat of global climate change. The Energy Committee looks forward to working with the Administration on this issue.

Senator James A. McClure
Committee on Energy and Natural Resources
April 5, 1990

NATIONAL ENERGY POLICY ACT OF 1990

Good morning. I wish to thank the chairman for convening this hearing which is a culmination of three years of committee oversight hearings on the status of current knowledge regarding global climate changes.

Humankind has become a more important agent of environmental change than nature. There are, however, policies that we can more sensibly pursue than we have in the past. These include: measures to conserve energy and water resources; R&D initiatives to further the development of promising alternative energy sources; and programs to spur reforestation and to slow deforestation. These initiatives also include continued support for the development and deployment of clean coal technologies, which offer the best opportunity to reduce carbon dioxide emissions, both here and abroad, while improving the efficiency of coal-fired electricity generation. These policies should be pursued regardless of the outcome of current research efforts on global climate change.

Nevertheless, we should resist calls for immediate and drastic reductions in U.S. carbon dioxide emissions -- at least until we better understand the likelihood of man-made climate changes in the 21st century.

2

Whether the issue is global environmental change or natural hazards, it is the developing countries of the world that will bear the most. The economically wealthy nations of the world have the resiliency and resources to deal with such problems. But the economic development of the rest of the world is intimately bound to our success in the quest to find cost-effective solutions to such global issues as climate change.

Because of concern for predicted changes in the global climate, the United States recently joined with over 70 other nations supporting stabilization of carbon dioxide emissions. Aggressive energy conservation and reforestation programs in the United States already are playing a leading role in this effort. The Federal government is committed to total phase-out of CFC's by the year 2000. Anticipated Clean Air Act amendments and improved automobile fuel efficiency will further reduce greenhouse gases.

Last June, at the Paris symposium on "Planet Earth", Frank Press, the distinguished president of the National Academy of Sciences (NAS), painted the following picture:

> "Substantial reductions of carbon dioxide emissions ... will require a change in the economy of the world, at costs ranging from hundreds of billions to perhaps trillions of dollars, and may not be technically feasible over the next 40 years."

In view of the costs associated with addressing carbon dioxide as just

this one cause of global temperature increases, Frank Press recommended against making "such large investments at this time". These words are neither mine nor those of an industry spokesman questioning the significance of predicted rises in global temperature.

Without question, humankind is altering the composition of the earth's atmosphere at an unprecedented rate. Available predictions indicate potentially severe economic and social dislocations for future generations. But uncertainties still exist regarding the magnitude, timing and regional effects of climate change due to human activity.

Clearly, additional research on a range of climate issues, including historic natural changes in the environment, the ocean-atmosphere relationship, and the influence of clouds in the global climate equation. Such an undertaking would generate the quality information so desperately needed by policy-makers in the current world-wide debate. And the answers would be forthcoming in relatively short order.

Through such an investment, the government can accelerate the pace of climate research to yield the necessary information in years rather than decades, so that timely action can be taken if needed. Such an approach is comparatively inexpensive compared to the costs associated with proposed environmental controls.

The Department of Energy has a major role to perform in this effort, and the substitute for S. 324, on which you have been requested to testify today, attempts to define that role.

Beginning last November Committee staff undertook to rewrite S. 324 to reflect testimony over the last three years from the Administration and others. The staff sought to achieve five objectives:

- First, any goals would be consistent with the 1989 Noordwijk Declaration on Atmospheric Pollution and Climate Change to which the U.S. is a party; *namely, that there is a need to investigate the feasibility and economic, energy, and environmental implications of achieving a 20 percent reduction in the generation of carbon dioxide emissions by the year 2000 as recommended by the 1988 Toronto Scientific World Conference on the Changing Atmosphere.*

- Second, the substitute would address only programs within the jurisdiction of the Energy and Natural Resources.

- Third, the substitute would emphasize Department of Energy research and development programs.

- Fourth, any new reporting requirements would be merged into the Secretary's biennial National Energy Policy Plans and would reflect the Secretary's efforts to formulate a National Energy Strategy.

- And, fifth, the Administration would be provided an opportunity to testify on the substitute.

In my judgment, these conditions have been generally satisfied by the proposed substitute. However, this is an important measure, which has over 30 cosponsors. The Committee also has invested considerable time and

attention to it. Nevertheless, further attention needs to be given to strengthening those provisions which advance our understanding of the feasibility and economic, energy and environmental implications of reducing the generation of carbon dioxides.

The Department of Energy has a unique role in helping us achieve that goal. The Department also can serve a unique role in national efforts to understand the consequences of global climate change.

I encourage the Department to cooperate with the Committee in achievement of this objective and I look forward to hearing today's testimony.

Statement Of Senator Rockefeller
Before the Senate Committee On
Energy and Natural Resources
On the National Energy Policy Act
April 5, 1990

I commend the sponsors of this legislation for their persistence in working on an overall approach to energy policy. That is something we need badly.

After years of neglect, the current state of our energy policy is not good. Our continuously rising dependence on foreign oil is alarming. Our margin for error in the face of economic and environmental problems is slim.

As a result, we need to reevaluate and take action, but we also need to proceed with care. The redraft of S. 324 has a number of good elements. In other respects I still have questions.

Is the legislation balanced, or does it overemphasize certain resources? Does the legislation take a long enough view, recognizing the future limits and possibilities for certain fuels? Does the legislation take into account the full impact of energy policy on the economy and jobs, as well as on the environment?

I look forward to discussing these and other issues with my colleagues on the Committee in the days ahead. And I commend the sponsors of the bill for all the work they have put into this effort.

STATEMENT OF U. S. SENATOR SPARK MATSUNAGA
BEFORE THE SENATE ENERGY & NATURAL RESOURCES COMMITTEE
IN CONSIDERING S. 324, THE NATIONAL ENERGY POLICY ACT OF 1990
366 Dirksen Senate Office Building
Washington, D. C.
Thursday, April 5, 1990 - 9:30 a.m.

The Energy & Natural Resources Committee is to be congratulated for its initiative in endeavoring to craft a bill for the purpose of establishing a national energy policy, especially one with environmental objectives, as is the case with S. 324, introduced by Senator Wirth. I am grateful for the opportunity to testify before the Committee in its behalf, Mr. Chairman, and I am proud to be not only a co-sponsor of the measure, but a co-author as well, by virtue of its inclusion of S. 639, a bill to establish a national program of hydrogen research and development, which I introduced, among its multiple provisions.

Moreover, I have had the opportunity to review the Committee's draft amendment of S. 324, wherein Title I of S. 639 remains in tact, and believe it to be, in the main, an improved bill in terms of achieving a manageable, single piece of legislation. It would still be a manageable bill and a stronger one, in my own estimation, had the amendment included S. 639's Title on hydrogen as an aviation fuel, Mr. Chairman, but having offered this bill in five Congresses at this point I will take what I can get.

S. 324 is an extremely broad piece of legislation, even in its slimed down form as represented in the draft committee amendment. But it does have a specific purpose: reducing the generation of carbon dioxide and other so-called "greenhouse" gases in order to slow the pace and degree of potential global climatic change. The bill, then, addresses an issue of even greater moment than the necessity for a national energy policy, that of global warming. The pace of climatic change may be debatable, but the indicators of it are not -- nor by their nature do they afford us the time required for scientific certitude before prudence dictates mitigating actions.

The actions offered by this bill for achieving reduction are numerous: least-cost utility planning incentives, energy efficiency techniques including fuel switching, innovative clean-coal and renewable energy technologies, reforestation and natural resource management policies, and international energy technology transfer for the purpose of fostering sustained economic growth in addition to achieving a secure domestic energy supply as well as environmental protection.

The form of energy we use is at the heart of virtually all environmental issues. This is why my own bill is so important to S. 324's purpose. Hydrogen is one of the most abundant elements in the universe, with water, a primary source of hydrogen, covering three-fourths of the Earth. Indeed, hydrogen plays a role in such varied everyday products as peanut butter, vitamin C, and aspirin, not to mention such larger products as clear plate glass windows.

As a transportation fuel, hydrogen's environmental benefits are particularly apparent Moreover, hydrogen can be transported more efficiently and at less cost than electricity over long distances.

Only last fall Mercedes-Benz demonstrated a hydrogen-powered vehicle here on Capitol Hill by offering Members of Congress rides in a sedan fueled by low-temperature hydride hydrogen. In 1988 Soviet television announced the triumph of an ordinary airplane flight using hydrogen fuel for the first time and showed the plane in the air with its jet stream of condensing steam instead of the usual kerosene smoke.

On the ground, the Soviets are in the process of turning out 100 hydrogen fuel cell powered vans and have joined forces with the Hungarian bus manufacturer Ikarus to adapt a 6,500 kilogram vehicle to a 40 kilowatt hydrogen-air fuel cell bus. A number of 12-passenger vehicles are being operated in Moscow with this technology on a hybrid basis with gasoline and a number of exclusively hydrogen powered vehicles, including taxis, are being demonstrated on the streets of Moscow and Kharkov. Elsewhere in Europe several municipal governments are considering conversion of bus fleets to hydrogen.

Perhaps the most startling development in the hydrogen field is the contemplated $500 million hydrogen energy project under consideration by the Province of Quebec in association with the European Economic Community. This would involve the construction of a liquid hydrogen plant in the 100 megawatt range on the St. Lawrence Seaway with its output shipped to Europe in either liquid cryogenic form as ammonia or a form of liquid hydride as in the case of the Mercedes-Benz vehicle. There it would be used as fuel for transport, for testing advanced aerospace engines and for district heating purposes. Shipments would be made aboard a 20,000 ton gas tanker yet to be built but designed for at least 15 round trips a year. There is great interest in this undertaking among West German industrialists who forsee hydrogen fuels rapidly becoming cost competitive with fossil fuels as the cost of pollution becomes fully reflected in the price of energy.

Against this background, S. 324's hydrogen title represents a modest proposal but an essential one if the

fragmented work in hydrogen on the part of the federal government is to be pulled together in an organized fashion. It calls for two 5-year development programs: one of $55 million for research and development in hydrogen production and use. This legislation reflects recommendations made by the National Academy of Sciences, the General Accounting Office and the Department of Energy over the last ten years. I have been advocating this legislation since the 97th Congress and its cogency becomes more apparent with each passing year. Hydrogen has definite environmental advantages over fossil fuels, because the product of hydrogen combustion with air is essentially water vapor.

Hydrogen's appeal to solar proponents is apparent since it is environmentally benign; indeed, it can act in behalf of environmental enhancement. For example, hydrogen has a key role in the process of nitrogen fixation whereby agricultural soils are replenished periodically. Also, there is the search for a replacement for the fully halogenated halocarbons used in refrigerants, solvents, and the like that have been found to be the culprit in the erosion of the ozone layer. One criteria in the search for a replacement is that it should be capable of introducing hydrogen into its chemical bond.

Furthermore, the renewables represent the most promising source for hydrogen's production in terms of energy expended in the process. Finally, hydrogen is key to assuring continuity of supply for solar power by providing a ready storage medium whether overnight or until the clouds scatter in the sky.

S. 324 addresses a serious global situation that demands a Congressional response. It does so in a responsible, broad-gauged fashion by encouraging energy efficiency and renewable technologies, environmental measures that should be fostered irrespective of world warming rates. In all modesty, Mr. Chairman, its hydrogen section is one of its strongest provisions. Nevertheless, I can endorse all of the bill's provision and I urge favorable committee action on the legislation as a whole. Thank you.

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United States Senate
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510-6150

March 26, 1990

MEMORANDUM

TO: Members and L.A.s, Committee on Energy and Natural Resources

FROM: Leslie Black
Professional Staff

RE: Summary of Joint Staff Draft of National Energy Policy Act of 1990

A hearing has been scheduled for 9:30 a.m., Thursday April 5, 1990, in SD-366, to receive testimony from Administration witnesses on the joint staff draft of the National Energy Policy Act of 1990. The Secretary of Energy, Admiral Watkins, and the President's White House Science Advisor, Dr. Alan Bromley have been invited to present testimony on the pending legislation. Mark-up is anticipated after the April recess.

The following is a brief section-by-section summary of the joint staff draft of the Act.

Summary

The purpose of this Act is to establish a national energy policy that will lead to a reduction in the generation of carbon dioxide and other greenhouse gases in order to slow the pace and degree of potential global climate change. The bill focuses on least-cost planning, energy efficiency, and fuel switching; innovative clean-coal and renewable energy technologies; reforestation and natural resource management policies; and international energy technology transfer in order to help ensure sustained economic growth and development, achieve a secure domestic energy supply, and protect the environment against potential climatic change.

Least-Cost National Energy Strategy -- requires the development of a "Least-Cost National Energy Plan" designed to meet the goal of a stabilization of carbon dioxide and other greenhouse gas emissions through an appropriate mix of Federal and State energy policies. The Plan is intended to outline policies and assign priorities for the conservation of energy from fossil fuels and an expansion in the use of renewable energy sources in order to meet short-, medium-, and long-term domestic energy demands while reducing the generation of carbon dioxide.

Director of Climate Protection -- requires the Secretary of Energy to appoint a Director of Climate Protection (hereafter the "Director") to serve as the Department's representative on all interagency and multilateral policy discussions regarding global climate change. The Director will be encouraged to participate in the formulation of a national energy strategy and the establishment of a Departmental management plan with regard to research and development.

National Academy of Sciences Review -- calls for the Director, in consultation with the Office of Science and Technology Policy, to call on the National Academies of Science and Engineering to conduct an extensive review of the current scientific knowledge regarding global climate change. Upon completion, the report will be presented to Congress and the President for use in establishing energy and natural resource policy with regard to global climate change.

Federal Energy-Environmental Coordinating Council -- establishes a coordinating council consisting of members from relevant Federal agencies, National laboratories, and the scientific and academic communities to identify and assess energy and environmental issues affecting Federal programs and activities. The Council will be responsible for preparing a comprehensive research plan to identify the relationship between energy use and global climate change.

Energy Efficiency Initiatives -- directs the Secretary to give energy efficiency high priority in the areas of planning, research and development, private assistance, and Federal procurement. The Secretary is directed to prepare a report which evaluates energy efficiency policies and their relative contribution to a decrease in U.S. energy use per unit of GNP. In addition, the legislation outlines specific energy efficiency programs including:

Centers for Energy Intensive Industries -- directs the Secretary to pursue a research and development program and joint venture program to improve efficiency in energy intensive industries and industrial processes. Authorizes $5 million for 1991, $15 million for 1992, and $25 million for 1993.

Federal Energy Management -- amends NECPA to direct the Federal government to employ where feasible, energy efficiency technologies and renewable and alternative clean energy sources in the construction or acquisition of Federal facilities. The Act also amends the policy for leasing buildings for Federal use by setting criteria for improvements in energy efficiency and renewable energy use. (S. 2191)

Repeal of Prohibitions on Supply and Installation of Residential Energy Conservation Measures -- repeals section 216 of NECPA to permit utilities to participate in the supply and installation of residential conservation measures.

Home Energy Efficiency Ratings -- directs the Secretary in conjunction with the Secretary of HUD, to promulgate guidelines for regulations to assign energy efficiency ratings for residential buildings.

Energy Efficiency Labeling for Windows and Window Systems -- directs appropriate Federal agencies to prescribe labeling rules and establish test procedures in order to assist consumers in making purchasing decisions.

Energy Efficiency Information -- directs the Administrator of the EIA to ensure that the National Energy Information System contains information necessary to calculate trends in energy efficiency.

Compact Fluorescent Lamps in Federal Facilities -- requires the Secretary to submit a report on the feasibility of using compact fluorescent lights in Federal facilities.

Amendments to PURPA/Encouragement of Least-Cost Investments -- requires State utility commissions to consider revising their ratemaking practices in order to remove existing disincentives for regulated utilities to invest in conservation and other means of demand reduction when such measures constitute the least-cost supply option. Unregulated utilities would similarly be required to consider implementing demand reduction measures when they constitute the least-cost supply option.

Energy Research and Development Priorities -- directs the Secretary to set priorities and prepare a management plan for research and development programs for renewable and other energy resource alternatives which reduce the generation of carbon dioxide and other greenhouse gases. The subtitle authorizes the Department to conduct joint ventures pursuant to the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989. (S. 488)

Engine and Vehicle Fuel Research -- instructs the Secretary to establish and carry out a program of research, development and demonstration on advanced vehicle engine systems, including those engines which run on alternative fuels and reformulated gasoline.

High Efficiency Heat Engines -- instructs the Secretary to establish and carry out a program of research, development and demonstration on high efficiency heat engines including advanced gas turbine cycles. Authorizes $25 million for each of fiscal years 1991, 1992, and 1993.

Hydrogen -- directs the Secretary to establish research and development goals and prepare management and program plans for the production, transportation, transmission, distribution, storage, and use of hydrogen. Authorizes $10 million for 1991, $15 million for 1992, and $20 million for 1993. (S. 639)

Fusion -- directs the Secretary to establish research and development goals and prepare program plans for magnetic and inertial confinement fusion for the production of electricity.

Coal -- directs the Secretary to establish research, development, and demonstration goals and develop a program plan for the development of coal technologies which meet the goals of the Act.

Natural Gas/Mass Transit Program -- provides for cooperative agreements and financial assistance to municipal, county, or regional transit authorities in large urban areas to demonstrate the feasibility of using natural gas or liquefied petroleum gas (hereafter, "LPG") as a fuel for mass transit. Authorizes $30 million for each of fiscal years 1991, 1992, and 1993.

Natural Gas Use in Fleet Vehicles -- establishes a joint program to provide financial assistance to encourage the development and commercialization of natural gas and LPG use in passenger fleets, light duty trucks, and heavy duty trucks. Authorizes $30 million for each of fiscal years 1991, 1992, and 1993.

Natural Gas/Training Program -- establishes a Department of Energy training and certification program for technicians who install equipment that converts gasoline or diesel powered vehicles to those vehicles capable of running on natural gas or LPG. Authorizes $5 million for each of the fiscal years 1991, 1992, and 1993.

Vehicle Research, Development, and Demonstration Program -- establishes a program of research, development, and demonstration on techniques related to improving natural gas or LPG vehicle technology. Authorizes $10 million for each of the fiscal years 1991, 1992, and 1993.

Natural Gas Recovery, Research, Development and Demonstration Program -- directs the Secretary to continue and expand a program of research, development, and demonstration on techniques to increase the recovery of natural gas. Authorizes $25 million for each of the fiscal years 1991, 1992, and 1993.

Natural Gas Heating and Cooling Technologies -- expands the program for research, development, and demonstration for natural gas heating and cooling technologies for residential and commercial buildings. Authorizes $10 million for each of the fiscal years 1991, 1992, and 1993.

Methane Assessment -- establishes national goals for the assessment and reduction of methane emissions. Directs relevant Federal agencies to prepare reports outlining domestic and international measures necessary to reduce methane generation associated with various energy and natural resource sectors.

Federal Energy Technology Transfer Council -- establishes a Council designed to foster U.S. policies which will enhance economic

development in less-developed countries and reduce the generation of carbon dioxide and other greenhouse gases through the increased transfer of energy efficient and renewable energy technologies. Authorizes $10 million for 1991 and such sums as may be necessary thereafter.

Ecological and Environmental Resource Study -- directs the Secretary of the Interior to conduct a study of the ecological and environmental resources that may be affected by global climate change.

National Forestation Initiative -- calls for a report on the feasibility of a National Reforestation Initiative designed to help stabilize or reduce the build-up of carbon dioxide in the atmosphere.

Urban Forestry and Energy Savings -- directs the Secretary to conduct a study regarding the potential for reducing the generation of carbon dioxide through urban tree plantings designed to reduce the air-conditioning needs of buildings.

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United States Senate
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510-6150

April 4, 1990

MEMORANDUM

TO: Members and LA's - Committee on Energy and Natural Resources

FROM: Allen Stayman, Committee Staff

RE: Hearing on S. 2191 concurrent with hearing on the National Energy Policy Act of 1990.

A hearing has been scheduled for Thursday, April 5, at 9:30 a.m., in SD-366 on the joint staff draft of the National Energy Policy Act of 1990. Section 203 of this draft includes the text of S. 2191, the Federal Energy Management Amendments of 1990, which is also on the agenda for this hearing. This bill is a revision of provisions regarding energy use by the Federal government from the Clean Air Act Amendments, S. 1630, as reported from the Committee on Environment and Public Works. The originator of the Clean Air Act provisions, Senator Leiberman, will testify on S. 2191. Following is a summary of the bill and general background information.

Background:

The federal government is the largest energy user in the nation. Each year the government spends nearly $4 billion for energy used in its 500,000 buildings. In response to the oil price shocks of the early 1970's the government undertook efforts to reduce its energy consumption. The basic authority for this effort is Title V, Part 3, of the National Energy Conservation Policy Act (NECPA). In general, this authority provides for the development and implementation of a ten-year federal buildings energy conservation plan; establishment of standards for federal operations, procurement and construction; and the establishment of a goal of 20 percent reduction in federal buildings energy use from 1975 to 1985. During this period the federal government reduced building energy consumption by nearly 17 percent. However, Department of Energy experts at the Lawrence Berkeley Laboratory estimate that by completing the most cost-effective energy efficiency projects remaining (those with a pay-back period of 5 years or less) the federal government could reduce its energy bill by another 25 percent and save an additional $1 billion annually. Unfortunately, the federal government does not

have the funds available to finance these projects, and thus, substantial additional savings are unrealized.

The Committee has enacted two measures in an effort to facilitate the realization of these potential savings. First, P.L. 99-272, the 1985 Budget Reconciliation Act, authorized Federal agencies to use so-called "shared-savings" contracts which would allow third parties to finance Federal energy improvement projects in exchange for a share of the resulting cost savings. Second, P.L. 100-615, the Federal Energy Management Improvement Act of 1988, updated and strengthened Part 3, Title V, of NECPA by: requiring agencies to establish incentives for the use of shared savings contracts; updating the program goals which had expired in 1985; and establishing an interagency Task Force to coordinate and promote agency efforts.

S. 2191

The pending legislation would further amend Part 3, Title V, of NECPA by:

- replacing the current energy management goal of a 10 percent reduction in energy use by 1995 (from 1985 energy use) with a requirement that all cost-effective energy conservation measures with payback periods of 10 years or less shall be installed by the year 2000;

- expanding the definition of energy efficiency to include renewable and alternative clean energy sources (fuel cells);

- modifying the procedures by which an agency may exclude a building or facility from the conservation requirement if it is impractical to comply;

- updating agency planning requirements to conform to the new requirements and the new compliance dates;

- requiring consultation with the Administrator of the EPA during the development of the procedures for estimating and comparing the life cycle costs of Federal building energy systems so as to include the value of environmental externalities;

- extending the proposed energy management requirements to Federally leased buildings; and

- specifying the procedures to be used in undertaking projects financed under "shared-savings" contracts.

Senator WIRTH. Senator Lieberman, thank you very much for coming. Senator Lieberman comes off of three months of very difficult, hard and proper advocacy for the Clean Air bill and we so appreciate all the good work that you did on that front. We are delighted to have you here this morning. Thank you for joining us.

STATEMENT OF HON. JOSEPH I. LIEBERMAN, U.S. SENATOR FROM CONNECTICUT

Senator LIEBERMAN. Thank you for your support in that effort and our mutual attempts to try to strengthen the bill and particularly make it responsive to the concerns about global warming and energy conservation.

Mr. Chairman, I appreciate very much this opportunity to be here with you today, and I commend, as you said, Chairman Johnston, yourself, other members of the Committee for your leadership on energy legislation.

The bill before you is a comprehensive bill and an important one, and I support it all, but I am here to testify specifically on behalf of section 203, which amends part 3 of Title V of the National Energy Conservation Policy Act. In fact, this section of this bill grows out of my own involvement in the Clean Air Act and my own cooperation with the Chairman of this Committee, Senator Johnston, who I think appropriately felt that some of the proposals that we were making as part of the Clean Air Act better belonged in the jurisdiction of this Committee and was good enough to go ahead and introduce this part of this bill before this Committee, and I am privileged to be a co-sponsor of both.

I have testimony which I would like to ask to be included in the record.

Senator WIRTH. Without objection.

Senator LIEBERMAN. I would like to draw from it briefly.

I got into the energy conservation renewable energy source. Part of the problem is part of our clean air discussion of acid rain, and clearly the acid rain problem is primarily a problem caused by utilities burning higher sulfur sources of fuel, particular coal in this case.

It seemed to me that there were many ways to go at this particular problem. One was the way the bill was generally doing, and the other was to recognize the reality that if we are burning less fossil fuel, particularly high sulfur fossil fuel to create the energy, if we are using less energy because of energy conservation, then there is simply going to be less of an acid rain problem and specifically with regard to your focus here today clearly less of a carbon dioxide and, therefore, global warming problem.

So the essence of this proposal, this section of the bill before you is to recognize the fact that through energy conservation through the use of alternative renewable sources of energy, we can achieve reductions in emissions that cause acid rain and that cause global warming.

My remarks today are going to focus primarily on the environmental aspects of this provision, but I think it is very important to stress that there are important benefits to national energy policy and, in fact, to national economic policy insofar as the use of

energy conservation and renewable energy sources is an outstanding way to save a lot of money and, therefore, contribute to the realization of the goal that all of us are aspiring to which is to reduce the budget deficit.

The fact is that the Federal Government is the largest single consumer of electricity in this country. We spend about $4 billion a year on energy for Federal facilities in the United States, and that is the fact that is at the heart of these proposals.

Section 203 may require some up-front money to implement its suggestions, but overall it is a big money saver. A twenty-five percent reduction in Federal energy consumption which is, I think, realizable through conservation and the introduction of renewable energy sources can save $1 billion a year.

This section 203 is targeted to measures that are cost-effective. It requires each Federal agency to install energy conservation and efficiency improvements and alternative and renewable clean energy technologies that have a payback time of ten years or less. The provision directs Federal agencies to use the cost-effectiveness formula developed by the National Institute of Standards and Technology, and that will incorporate elements of environmental cost as determined by the Administrator of the Environmental Protection Agency.

Fuel cells, solar, wind, geothermal and biomass are energy-producing technologies that offer tremendous environmental benefits. They produce energy with virtually no emissions, and in many cases they are totally renewable. Section 203 would encourage these technologies if they meet the cost effectiveness test.

I think the problem is that too many people perceive these technologies as, if I may use the term, somewhat flaky ideas that have little application in the real world. We are continually told that they are unproven, prohibitively expensive and something for the future, but the fact is that geothermal and biomass are already competitively supplying baseload electric generation capacity in parts of this country. Since 1981 the costs of wind and solar power have decreased dramatically. Competitively priced fuel cells will be commercially available in the next few years.

So these technologies are here today, and section 203 of this bill recognizes that and also recognizes the responsibility of the Federal Government as a consumer of electricity and a consumer of taxpayer dollars to be a leader in this area.

A recent Department of Energy initiative focused on energy conservation in Federal buildings. DOE in fact projected that with an investment of $336 million over five years, the potential total payback for the country is $32 billion over 20 years. Now Mr. Chairman, those are not my numbers, and perhaps I should repeat them because DOE in its prepared testimony for today expresses some skepticism, one might almost say opposition to parts of this bill.

Let me just repeat it. DOE, by its own estimate, has projected that with an investment of $336 million over five years in energy conservation and the use of renewable sources, the potential total payback for the country is $32 billion over 20 years.

The DOE initiative also indicates that it is going to assist other Federal agencies in developing innovative financing options that would minimize the need for up-front Federal investments, and

this is an important part of section 203. It establishes what I would consider to be a practical statutory framework for procurement officials in all agencies to use some innovative shared energy savings contracts that have been used for the last 15 years by State and local governments.

Let me just very briefly say that these work in the following way. An energy services company is retained to install and pay for the energy conservation measures. It does not require any payment by the Federal Government. It receives its compensation as a percentage of the money saved by agreement to a formula over a set period of time, usually ten years, and that immediately reduces the amount the Federal Government has to pay for electricity.

In my opinion, that is as close to a win-win situation as I have ever seen. It takes some of the kind of innovative financing mechanisms that are used in the private sector and puts it to work in the public sector.

Mr. Chairman, it has been 20 years now since the first Earth Day. We are building up to the 20th anniversary celebration. I think in the 20 years we have learned a lot about the fragility of our global environment, and since the first Arab oil embargo in the 1970s we have also learned a lot about how important it is for us to treat our limited energy supplies respectfully.

I think that aggressive energy conservation is good energy policy and good environmental policy, and I think that the Federal Government, as the largest consumer of electricity in our country, ought to lead the way and set a standard for the rest of the country in achieving both better energy use and a cleaner environment.

Mr. Chairman, let me just repeat briefly what I said before you arrived, which is to thank you for co-sponsoring these parts of the bill that did grow out of some work that we were doing on the Clean Air Act and which, I think you quite correctly said more appropriately, should be considered by this Committee and particularly as part of this bill. I look forward to working with you and other Members of the Committee on these measures as we go along.

[The prepared statement of Senator Lieberman follows:]

Statement by
Senator Joseph I. Lieberman
before the
Committee on Energy and Natural Resources
United States Senate

April 5, 1990

Mr. Chairman, Members of the Committee:

I appreciate this opportunity to testify before the Committee on Energy and Natural Resources with regard to the National Energy Policy Act of 1990. I commend you Mr. Chairman, as well as Senator Wirth and Senator McClure for your leadership on this energy legislation.

This is a comprehensive Bill that recognizes that national energy policy is a key to slowing the pace of global warming. While I support the entire Bill, I am here today to testify specifically in behalf of Section 203 which amends Part 3 of Title V of the National Energy Conservation Policy Act. It is based, in turn, on the provisions of S. 2191 authored by the Chairman, which I cosponsored, and derives from provisions I originally offered to Section 403 of the Clean Air Act.

In brief, Section 203 of the Federal Energy Management Amendments requires Federal Agencies to adopt cost effective energy conservation programs at Federally owned or leased facilities. It requires Federal agencies to consider alternative renewable and clean energy generating technologies as they develop energy conservation plans and it provides a specific

procedure for federal facility managers to use to enter into shared savings, energy conservation contracts.

Throughout the debate on the Clean Air Act Amendments, we focused on acid rain and its costs to our health, our environment and our economic welfare. Regardless of how they are computed, the controls associated with acid rain are going to cost a lot of money. I have argued, and will continue to argue, that the health and environmental benefits of the Clean Air Act Amendments far outweigh the costs. However, there are cost effective steps that the nation and the government in particular can take to reduce acid rain-causing emissions. Section 203 focuses on energy conservation and alternative and renewable clean energy generating technologies that can help achieve that goal.

The solutions to acid rain, air toxics and smog, as the Committee understands, are irtrinsically tied to the demand, supply and consumption of energy. As a result, the line between environmental policy and energy policy has become blurred. While the National Energy Policy Act is crafted as a piece of energy legislation, it is also a critical piece of environmental legislation.

While my remarks today will focus primarily on the environmental aspects of Section 203, I want to emphasize that it offers important benefits to national energy policy and Federal budget reduction, as well.

The Federal government is the largest single consumer of electricity in this country. We spend about $4 billion on energy for Federal facilities in the United States each year.

There was much understandable concern over the impact of the Clean Air Act Amendments on rate-payers. Well, Uncle Sam is the country's biggest rate-payer.

The demand for and generation of electricity from traditional fuel sources is at the heart of not only the acid rain problem, but also global warming. As the largest single consumer of electricity, the Federal government is part of the problem. Section 203 takes steps to reduce the contribution of the government to acid rain as well as to overall carbon dioxide emissions.

Energy conservation is, quite simply, the most effective, cost-efficient and natural resource protective technology available to prevent acid rain. Conservation reduces electric demand. Reduced electric demand leads directly to reduced electric generation. Reduced electric generation leads directly to less acid rain producing emissions. It is that simple.

If we in the government are really serious about acid rain, we should become part of the solution, instead of remaining part of the problem. Section 203 directs the government to do its part by practicing electric energy conservation.

Section 203 may require some upfront money to implement. But overall, it is a big money-saver. A 25% reduction in federal energy consumption can save $1 billion a year.

Section 203 is targeted to measures that are cost effective. It requires each federal agency to install energy conservation and efficiency improvements, and alternative and renewable clean energy technologies that have a payback time of 10 years or less.

This provision directs federal agencies to use the cost-effectiveness formula developed by the National Institute of Standards and Technology. This formula will incorporate the value of environmental externalities as determined by the Administrator of the Environmental Protection Agency. The determination of these values is an important step that has already been implemented by the New York State Public Utility Commission and is under consideration by many other states. Further, the incorporation of environmental externalities is the highest priority of the Conservation Committee of the National Association of Regulatory Utility Commissioners.

Pollution prevention is an important new approach to achieving tangible environmental gains at the least cost to society. The best incentive for pollution prevention in the energy sector is an honest accounting of all costs associated with energy generation. Determining the value of environmental externalities provides the market with the information it requires to meet our energy needs in the most efficient manner.

Fuel cells, solar, wind, geothermal and biomass are energy producing technologies that offer tremendous environmental benefits. They produce energy with virtually no emissions. And in many cases they are totally renewable. Section 203 would also encourage these technologies if they meet the cost-effectiveness test.

The problem is that too many perceive these technologies as flaky ideas that have little application in the real world. We are continually told that these technologies are unproven, prohibitively expensive and, if they're ever going to be available, it's in the far, distant future.

But, geothermal and biomass already competitively supply baseload electric generation capacity in some parts of the country. Since 1981 the costs of wind and solar power have decreased dramatically. Competitively priced fuel cells will be commercially available in the next few years.

These technologies are here today. Section 203 recognizes these promising, non-polluting technologies by directing Federal agencies to utilize them, to the extent that they meet a cost-effectiveness test that requires a ten year pay back on the investment.

A recent DOE initiative focused on energy conservation in Federal and commercial buildings, solar energy, waste to energy and similar energy saving innovations. DOE projects that, with

an investment of $336 million over five years, the potential total payback for the country is $32 billion over 20 years.

The DOE initiative also indicates that it will assist other Federal agencies in developing innovative financing options that would minimize the need for upfront Federal investments. Section 203 establishes a practical statutory framework for procurement officials in all agencies to use these innovative shared energy savings contracts.

For the last fifteen years, state and local governments have been retrofitting government buildings with energy conservation improvements without any capital investment. Our friends at the state and local level have been taking advantage of alternative funding arrangements.

As I understand it, the Federal government has only limited involvement in these benefitial public-private partnerships.

Shared savings contracts have two important features that are of particular interest to the Federal government.

1 An energy services company installs and pays for the energy conservation measures. It does not require an expenditure by the Federal government.

2 It immediately reduces the amount the Federal government has to pay for electricity.

That's as close to a win / win situation as I've ever seen.

With these contracts, private capital will finance conservation improvements in public buildings, with no requirement for a Federal budget commitment.

In the twenty years since the first Earth Day we have learned many important lessons about the fragility of the global environment. Since the first Arab oil embargo we have also learned important lessons about our reliance on sometimes tenuous energy supplies. Aggressive energy conservation is good energy policy and it's good environmental policy. The least we can do is insure that the Federal government is a model energy consumer. Section 203 of this Bill goes a long way toward making the Federal government a leader in energy conservation and clean energy installations.

The CHAIRMAN [presiding]. Thank you very much, Senator Lieberman.

Thank you, Senator Wirth, for getting us started in my late return from breakfast.

Senator Lieberman, I want particularly to thank you for your cooperation in bringing this legislation to the Committee. It was more appropriate to do it here than in the Clean Air Act.

At the same time, we are very interested in the thrust of your legislation. You may be familiar with the fact that we pioneered the concept in law back in 1986 of shared savings. When DOE said we do not have the money to do it, we said, all right, we will work with contractors who, in contracting with the government, will get their profit from the savings from energy conservation in the Federal Government.

It is a very great field. Indeed, conservation is probably the biggest source of domestic production we can have and certainly the only one as to which there seems to be real consensus.

I, personally, and some other Members of this Committee would suggest other means of getting large amounts of energy, perhaps not as great as through conservation. But there is no consensus on anything, I think, but conservation. So there are things where there is consensus and where there is a great possibility that we ought to pursue vigorously and aggressively. With your help and leadership and that of this Committee, Senator Wirth and others, we plan to do just that.

Senator LIEBERMAN. Thank you, Mr. Chairman.

The CHAIRMAN. We thank you for your statement.

I wonder if Senator Wirth has any questions.

Senator WIRTH. I was struck that you included most of the Lieberman legislation in section 203 of this bill, as you point out, and we thank you again on the Clean Air debate for deferring to the Energy Committee, wherein the responsibility lies.

The Secretary said when the national energy document strategy came out over this last weekend that, "The loudest single message that the agency heard during a year of nationwide hearings was the Nation can increase energy efficiency in every sector of use."

Every sector of use does include the Federal Government as well; right?

Senator LIEBERMAN. Absolutely, particularly since we stand out as the largest consumer of energy in the country.

Senator WIRTH. I am struck by the fact that, as I understand, they are not supporting section 203 of the legislation.

Senator LIEBERMAN. That appears to be the case.

Senator WIRTH. Do we have an alternative from the Department of Energy about what they do support in terms of what the Federal Government ought to be doing?

Senator LIEBERMAN. I would be interested to hear as you hear from the representatives of DOE. We did work with people in DOE in fashioning some of these proposals as they first occurred to me during the Clean Air debate.

As I say, on January 26 here is a statement from Deputy Secretary of Energy, W. Henson Moore, announcing a series of initiatives on energy efficiency and the use of renewable energy sources.

To my way of thinking, what we are trying to do in section 203 is totally consistent with this policy statement. You cannot read it without concluding that this is just one of the best things that the Federal Government can do with its money because of the tremendous savings that are involved here.

Senator WIRTH. Have you seen the Department of Energy's comments on this part of the legislation?

Senator LIEBERMAN. I saw them briefly last night, and I was just puzzled by them because they seem inconsistent with what I thought was the approach of the Department. I would be interested to hear as this goes on how they distinguish between what we are trying to do in section 203 and their own approach, which I support. I think what the Chairman has said is so true, and I had not thought about it in this way, which is that this is one of the few, maybe the only, areas where there is broadbased agreement. There is a consensus that energy conservation is a winner, and, therefore, we ought to take that consensus and make it into the most active policy we can.

Senator WIRTH. We look forward to working with you and seeing if we can understand, as well, the comments of the Department on the legislation. It seems to me the Federal Government has a responsibility to act and to be the leader rather than just the talker about this sort of thing.

Senator LIEBERMAN. I agree.

Mr. Chairman, if I may add one more point about another effect of this proposal which is also part of the reason I got interested in it.

The Federal Government, as a major consumer, also has the ability to help create a market for renewable energy approaches, renewable energy sources. I had an experience, just to repeat to you very briefly.

In Connecticut we have a company that has developed fuel cell technology, is working on it, and they are making substantial progress. It happens that it is at a stage of development where the cost to purchase one of these units is higher than the comparable.

If you look at the short-term asset/liability cost statement, it is higher cost than the comparable sources of energy, competitive sources of energy. These folks, because they have not been able to find a sufficient American market but want to stay in business, have ended up taking some very important technological breakthroughs they have achieved and in order to get enough cash to stay in business have found themselves having to license their developments to Japanese companies who are prepared to take a loss in the short run because they believe that fuel cell technology is going to be a booming business into the next century.

I must say that one of the positive benefits that this section has adopted, I believe, is that the Federal Government can help to make a sufficient American market for renewable energy sources and, in that sense, to help us develop our domestic capability to be strong in this area. I think that will have great payoff for us economically into the next century so that we have a foothold in what I think will be a growing world market instead of allowing others to benefit from the breakthroughs that we have achieved through our own industry.

The CHAIRMAN. Senator Domenici.

Senator DOMENICI. I just want to thank the Senator for his contribution.

The CHAIRMAN. Senator Rockefeller

Senator ROCKEFELLER. Likewise.

The CHAIRMAN. Next, we are pleased to have the honorable Allan Bromley, who is Science Advisor to the President and Director of the Office of Science and Technology. We are especially interested to hear from Dr. Bromley on the state of the science regarding global climate change, as there seems to be a great deal of debate surrounding the exact pace and degree of global climate change.

The legislation to be discussed this morning represents a joint committee effort to draft a comprehensive national energy policy to stabilize the generation of carbon dioxide and greenhouse gases as quickly as is technically and economically feasible.

The bill focuses on least-cost planning, energy efficiency, innovative renewable energy technologies, and energy technology transfer. These are all policies that are worth pursuing in and of themselves, even out of the context of global warming.

The fact that these policies would also reduce emissions of carbon dioxide and greenhouse gases is simply an extra bonus.

The completion of the joint staff amendment coincides with this week's release of DOE's National Energy Strategy Interim Report. Secretary Watkins stated publicly that he has placed seven options from the NES on the fast track, and assigned them to an interagency working group under the chairmanship of Hensen Moore.

The Committee is pleased that six of these critical goals are currently reflected in the joint staff substitute amendment. These are: integrated resource planning, enhanced energy efficiency, increased use of renewables, streamlined technology transfer, modelling of the U.S. energy economy, and pollution prevention.

When President Bush first initiated the National Energy Strategy in July of 1989, he stated that our bipartisan task is to build a national consensus necessary to support this strategy, and to make this strategy a living and dynamic document responsive to new knowledge and new ideas.

I believe that S. 324 will help to further the process of building a national energy strategy, while taking into consideration the threat of global climate change.

The Energy Committee looks forward to working with you, Dr. Bromley, and the Administration, on this issue. And I am particularly anxious to hear your testimony, because I know of your background and your expertise, and I hold you in great respect on this issue. And also I personally find this to be one of the most fascinating issues that has come before this committee.

So, with that, Dr. Allan Bromley.

STATEMENT OF D. ALLAN BROMLEY, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Dr. BROMLEY. Thank you, Mr. Chairman, Senators.

I am delighted to be here this morning to discuss with you the issue of enhanced greenhouse gases, and the potential global envi-

ronmental change that is related thereto. And I want to discuss with you, also, the activities in which the Administration is now engaged and the mechanisms that we have already put in place that we believe will lead to a scientifically and economically sound national energy strategy for dealing with this issue.

With your permission, Mr. Chairman, I will submit my formal testimony for the record, and abbreviate my remarks.

The CHAIRMAN. Yes, without objection.

Dr. BROMLEY. The Administration takes very seriously the threat of the potential global climate change and global climate change of any magnitude. We are devoting significant amounts of time and resources to understanding the state of the science, and responding appropriately to the perceived threat.

I believe that it is very important for me to state, as clearly as I can, the policies that we have in place, after numerous detailed discussions with some of the best scientific and economic minds in the country. And I speak today for my colleagues in the Executive Office of the President, as well as for the concerned cabinet secretaries and agency heads, including, in particular, Secretary Watkins and Administrator Reilly.

Notwithstanding our own national strategy, however, I also want to emphasize that any change in global climate obviously affects all nations, and thus, requires international concern, study, and cooperation, if practical and viable solutions to his potential problem are to be found.

It is this Administration's position that both our own national energy policy and the evolving international energy policy must be based on sound scientific, economic and technological considerations. All nations, developed and developing, must take an appropriate share of the burdens that such solutions necessarily will entail.

In the short term, this will mean that all countries will take immediate action on problems where a scientific consensus exists, and will work cooperatively to understand phenomena in key areas where a scientific consensus does not yet exist. And in that case, will nevertheless move forward with measures that would reduce emissions of greenhouse gases when it makes sense to do so—as you, Mr. Chairman, have noted—for other policy reasons.

Examples of the latter will include increasing energy efficiency, (I think that is one of the most important), conservation measures, phasing out the use of chlorofluorocarbons, working with the developing countries to reduce net deforestation—all to achieve internationally mandated environmental objectives without compromising the legitimate economic objectives for growth in these developing countries.

Before I describe what the Administration is currently doing, I would like to share with you a few of the scientific facts that underpin the Administration's position and activities in this global warming arena.

Virtually all scientists would agree that currently we have few certain, unequivocal facts or data that can be analyzed to provide an adequately clear picture, globally, or indeed regionally, as to what would happen if humanity continues to generate more and

more greenhouse gas emissions, concentrating in our upper atmosphere.

However, given that uncertainty, in order to get some idea of what might happen—to develop scenarios on which policies can be based—we make the assumption that all conditions currently observed will remain the same with the exception, say, that we double the amount of excess greenhouse gases in the atmosphere.

This is the fundamental basis of our modeling approach.

Then using what we believe to be the rate of temperature increase per increase in concentration of these gases, and the past chemistry and physics that we have available, we attempt to calculate what the temperature increase would be for, let us say, a doubling of the greenhouse gas concentration, and we include as much of the dynamics of the global situation as we think we understand.

Unfortunately, the calculations to date do not take into account a number of the dynamic feedback loops that nature has built into this problem. There are effects of rises and falls in temperatures, changes in the ocean circulation patterns, changes in cloud cover, changes in equilibrium points for gas absorption and saturation in natural processes.

These effects have not yet been taken into account simply because we do not yet understand them adequately to put them into our models in effective fashion.

Two obvious examples that have a dominant impact are cloud behavior and the ocean/atmosphere interface, and the exchange of carbon dioxide between the atmosphere and the ocean at this interface.

Clouds, we know, sir, have both positive and negative impacts, depending upon their nature and depending upon their altitude. As was illustrated in a recent scientific study in the United Kingdom, when the behavior of clouds and their water vapor content was more accurately modeled, the predicted global average temperature warming dropped from 5.2 degrees Celsius, to 1.9 degrees, a reduction of more than a factor of two.

Still, we have not yet developed a fundamental dynamic model of cloud behavior, so that even that 1.9 degrees Celsius figure has a large uncertainty still associated with it.

The behavior of oceans is another area where the science really is still in its infancy. It is essential to recognize that the top three meters of the ocean contain the same energy content as the entire atmosphere. It is also important to recognize that the ocean contains 50 times the carbon dioxide as does the entire atmosphere.

Until very recently, all scientists working in this field, I think without exception, believed that the anthropogenic carbon dioxide released into the atmosphere ended up 50 percent in the atmosphere and 50 percent in the planet's oceans.

Within the past two years, however, measurements on the partial pressure of carbon dioxide in the oceans have demonstrated that that fraction is closer to 25 percent. In effect, we have lost 25 percent of the carbon, and we do not yet know where it is.

Biologists do not agree with the physical scientists as to whether it in fact is in the biomass in the temperate zones. This is, at the moment, a substantial unknown, and we do not yet know how it impacts our climate calculations.

This is an illustration, Mr. Chairman and gentlemen, of the fact that each new major addition to the fundamental knowledge that we have has changed, in a substantial way, our predictions concerning the global climate scenarios. Given this level of uncertainty about global climate change, we need to continue aggressive research programs being supported by various Federal agencies to understand more fully the ramifications of increased greenhouse gases.

However, it is important also to emphasize, given these uncertainties, that there are data which quite rightly give us pause. We have the paleoecological data that goes back some 160,000 years obtained from experiments—originated by the Soviets on the ice cores from Antarctica—which allow us to track the content of carbon dioxide and the temperature back over that 160,000-year period.

We find that they track remarkably well. There is some remaining uncertainty as to which leads, but that will be resolved soon.

The other thing that has made a major difference, I think, in our understanding of global phenomenon, is the ozone hole, Mr. Chairman, because prior to the ozone hole most people, scientists and otherwise, believed as a matter of deep faith that the atmosphere and the planet were so large and had so great inertia that there was very little that humans could do to them, certainly not in the short time range.

The discovery of the ozone hole has made it very clear that humans can indeed make changes to the atmosphere and on a very short time scale.

Given that uncertainty and given those observations it seems to me that it is essential for us, as we work to understand better what our future holds, to take out the best insurance policy that we can against possible adverse effects resulting from greenhouse warming; these insurance policies are comprised of the kinds of initiative that you and Senator Wirth have mentioned already, actions that we take that will help the greenhouse situation but which have other important rationales as well.

Let me mention several initiatives already undertaken by the administration that will accomplish objectives similar to those in S. 324. Then let me describe our recent progress toward establishing a comprehensive research program as well as the mechanisms—both national and international—that we have developed for providing informed policy decisions and for implementing those decisions. These actions, in my view, constitute an effective response on the part of the administration to the goals that we share with you on the committee, goals that I think we share with most of the American people and that motivate the Act that is before us this morning.

Among the actions the administration has taken that will reduce greenhouse gas but which have other compelling rationales, for example, is our commitment to phase out the manufacturing and use of CFCs by the year 2000, ahead of the requirements of the current Montreal Protocol, and these constitute 25 percent of our current greenhouse gas emissions.

The Clean Air Legislation that is currently under debate in the Congress will also provide substantial reductions in the emission of some of the other greenhouse gases.

Also important, as we have heard several times this morning, I think perhaps as important as any other single action, is aggressive energy conservation—programs that will reduce our emission of carbon dioxide which constitutes 57 percent of our greenhouse emission. This will be, as you have heard, a cornerstone of the National Energy Strategy that the Department of Energy is currently pulling together. That addresses the source side of the problem.

Addressing the sink side, the Department of Agriculture's tree planting initiative, the planting of a billion trees on private land across the U.S. per year, trees that will eventually absorb about 13 million tons of carbon annually, the program presented in the fiscal year 1991 Presidential Budget, and our diplomatic discussions with nations such as Brazil that have large tropical forests and our efforts to work with them to preserve as much as possible of those tropical forests all constitute part of what I look on as our insurance program.

We have just released—the Energy Department has just released—a report on the wide-ranging public hearings that represent a very important and new step in the process of formulating the National Energy Strategy, and the item that has come to the top in all of the many meetings that were held across the nation is energy conservation. We have tremendous public support for aggressive conservation, and we now simply must, working together, the administration and you in the Congress, come up with the appropriate ways of responding to, and implementing that desire.

Finally, the President proposed, in the 1991 budget, funding for the U.S. global change research program increased by 57 percent to a total slightly over $1 billion. This is almost a factor of ten greater than the expenditure in any other nation in the world in understanding and responding to global change.

Now, let me turn to the question of policy formulation. As Assistant to the President for Science and Technology and as Director of OSTP I chair two complementary councils, one Federal, FCCSET (the Federal Coordinating Council for Science, Engineering and Technology), and one from the private sector, PCAST (the President's Council of Advisors in Science and Technology).

In addition, I chair working groups of both the Domestic Policy Council and the Economic Policy Council relating to matters of science and technology, and these groups whose functioning I would to describe briefly to you, Mr. Chairman, I believe accomplish the objectives, and many more besides, of the coordinating council that is proposed in S. 324.

First, the Federal Coordinating Council for Science, Engineering and Technology, FCCSET; research on global change is a good example of its successful function.

OSTP's mandate requires that we coordinate and integrate the programs of the individual agencies to the greatest extent possible, the intent being to obtain the maximum effective science and technology for every dollar that you gentlemen can make available to us.

The work in the past year related to global change has been carried out by the Committee on Earth Sciences chaired by Dr. Dallas Peck, the Director of the U.S. Geological Survey. Within that committee, in turn, there have been two subcommittees: One, the Working Group on Global Change chaired by Dr. Robert Corell of the National Science Foundation, and a new Working Group on Adaptation and Mitigation Technologies headed by Dr. John Knauss of the National Oceanic and Atmospheric Administration.

CES has integrated the efforts of seven Federal agencies conducting research on global change into the U.S. Global Change Research Program, and I would like to submit for the record, sir, the program document that that committee has produced and that is now considered a model for this kind of integration in nations around the world.

The CES expects to update this program on an annual basis and as new research results are obtained and as new understanding is brought in, including in particular private sector input, we will revise this plan as necessary.

The private sector group, PCAST, the President's Council of Advisors, was established by Executive Order of the President on January 19th of this year. It reports directly to the President. This is the first time in some two decades that we have had such a group reporting directly to the President. It comprises 12 very distinguished representatives of the private sector, and has already met twice with the President.

On each of those occasions one of the topics discussed at length was the matter of global change, and it is my intention to request that PCAST form, in the very near future, a panel on environmental science and global change to bring to the highest levels of the administration input from the private sector. This is an input that has been largely missing from the discussion thus far, and I think a very important one.

The fact that I have the honor of chairing both FCCSET and PCAST means that I have the responsibility and the opportunity to coordinate the intra-governmental activities of FCCSET and the private sector input from PCAST.

Within the Executive Office, President Bush has also asked me to chair a cabinet level Working Group on Global Change under the Domestic Policy Council. This provides Cabinet level coordination on global change issues and is an important direct source of advice to the President.

The Working Group was established last October, and we immediately called for three specific studies: One, an analysis of economic costs of global change and possible responses to it, two, an analysis of private sector concerns, activities and issues and, three, legal precedents for international agreements and conventions on the environment.

In addition, this working group has set up and participated in a series of briefings from top experts in the scientific, economic, environmental and industrial communities relating to global change.

I also chair a working group on science and technology for the Economic Policy Council. This group includes White House officials, senior representatives from all federal agencies and depart-

ments, and will have substantial involvement in the scientific and technical matters coming to Presidential attention.

Finally, in this area the President has asked me, together with the Chairman of the Council of Economic Advisors and the Chairman of the Council of Environmental Quality, to organize a White House conference on the science and economic research relevant to global change. This conference will be held April 17 and 18 of this year here in Washington. We will bring together the leading scientists, economists and environmentalists from a wide array of countries, and our intent is to inject economic reality into the discussions of global change, not only nationally but internationally.

We found that at the Noordwijk conference last fall that economics was conspicuous by its absence from much of the discussion at that conference. We look on this not as in any way interfering with the IPCC process that we were instrumental in setting up under the U.N. and with which we work aggressively, but rather as complementing, as broadening the discussion so that our policies and hopefully international policies will be more soundly based on good science and good economics.

The U.S. Government, of course, has played a very strong role—and will continue to play a strong role—in the IPCC process. The three working groups dealing with the science, the impacts, and the responses met here in plenary session in Washington roughly a month ago, and the final papers from those working groups will be presented to the full IPCC in August, shortly before the Second World Climate Convention.

So let me then conclude, gentlemen: A National Energy Strategy that I think will mark a major step forward in the activities of the Federal Government with respect to our energy policy is currently being developed by the administration. This strategy will respect the environment, meet our nation's needs for energy and not damage our economy or our international competitive position.

The Administration has already taken specific actions to begin dealing with the potential problem of global change by taking the initiative on CFCs, the clean air legislation, and a variety of other measures that I have mentioned.

We have in place, Mr. Chairman, a vigorous structure of coordinating advisory councils on global change that have demonstrated that they can, in fact, function effectively, and the Administration, I believe, is on top of this issue.

The only comment I would like to make directly on S. 324 concerns Title II which addresses energy efficiency. I believe that increase efficiency and conservation, as I have said before, offer our best short-term prospects for stabilizing greenhouse gas. If we go below stabilization, if we intend to reduce greenhouse emissions, then we will require among other things, in my belief, massive fuel switching in our generation of electrical energy.

In my considered opinion, Mr. Chairman, this will also involve greatly increased reliance on nuclear fission energy. Consequently in my view an effective long-term national energy plan must include research on advanced, inherently safe reactor concepts, concepts such as the advanced light water reactor and the high temperature gas cooled reactor. I make that statement, sir, because although I strongly support the research and development on a great

array of the energy sources that have been mentioned already this morning, I truly believe that they are niche energy sources that can play, and will play, very important niche roles, but for the large blocks of electrical energy that this nation will require to continue its economic growth—if we find it necessary to severely restrict our burning of fossil fuels—I believe that we have no alternative other than a new generation of intrinsically safe nuclear reactors. These critical elements are missing entirely from S. 324.

Beyond that, sir, I defer to the Department of Energy for specific administration comments on the legislation S. 324, and this will then conclude my prepared remarks. I should be happy to respond to questions.

[The prepared statement of Dr. Bromley follows:]

STATEMENT

by
D. Allan Bromley,
Assistant to the President for Science and Technology, and
Director, Office of Science and Technology Policy

before the
Committee on Energy and Natural Resources
United States Senate

on

S. 324
National Energy Policy Act of 1990

April 5, 1990

Thank you for the opportunity to present the views of the White House Office of Science and Technology Policy (OSTP) on S. 324, the National Energy Policy Act of 1990. OSTP and the entire Administration share the committee's conviction that our national energy policy must be based on sound environmental, economic, and technical considerations. However, we believe that mechanisms now in place offer a significantly better chance of developing and implementing such policy than do the measures in the Act. The Administration, therefore, opposes enactment of S.324.

SCIENTIFIC UNCERTAINTIES REGARDING GLOBAL CLIMATE CHANGE

There is no question that human beings have significantly altered the composition of the atmosphere by burning fossil fuels, cutting down forests to greatly expand agriculture, and producing industrial chemicals such as chlorofluorocarbons. Over the past two centuries, the amount of carbon dioxide in the atmosphere has risen 25 percent. The level of atmospheric methane, a potent greenhouse gas generated by agricultural and industrial practices, has more than doubled.

Although scientists have predicted since the end of the nineteenth century that increases in atmospheric carbon dioxide would increase the temperature of the planet, our understanding of the relationship between greenhouse gases and global climate change remains imprecise and inadequate. The scientific challenge is great, and our inability to separate human impact from natural variability and the uncertainties surrounding temperature records compounds the problem. Nevertheless, few scientists would argue with the contention that if we continue to load the atmosphere with greenhouse gases, we will eventually experience some degree of warming.

Our general understanding of radiative forcing mechanisms in the atmosphere leaves unanswered the critical questions regarding how much warming will occur, the timing of any warming, impacts on sea level, rainfall and soil moisture, and the regional effects created by all of these factors. Those who are following the literature know that new, and sometimes conflicting results on the predictions for future global changes appear almost on a daily basis.

It is also important to recognize that developing an improved understanding of geophysical climate processes is only the first step in developing appropriate policies. Estimates of the human and social consequences stemming from actions that might be taken to curtail greenhouse emission, as well as those stemming from predictions on future warming and ancillary changes associated with it, must then be developed and used as the basis for policy formulation. Science and economics research aimed at developing necessary estimates and insights is a top priority for the Administration.

Our scientific research is making significant progress. Nonetheless, the state of the science remains highly uncertain. In fact, several recent studies suggest a move to more moderate predictions of the extent of global climate change and its potential impacts. For example:

- In January of this year, a National Academy of Sciences panel concluded that current climate change models predict a global warming closer to 2 degrees Celsius over the next fifty years, not the previous range of 1.5 degrees to 4.5 degrees Celsius.

- In December 1989, the American Geophysical Union revised earlier estimates of rise in sea level of between 20 and 120

inches by the year 2100 to a new estimate of between 0 and 30 inches.

- o Recently U.K. scientists have introduced a better representation of cloud processes in their global climate change model. The new estimate of warming for a doubling of CO2 dropped to 1.9 degrees Celsius, down from the previous estimate of 5.2 degree Celsius.

- o In January of this year, NOAA reported new results from its global climate model, using more realistic ocean simulations. This model now predicts that even with a doubling of the current CO2 levels there would not be warming in the Southern Hemisphere. Indeed, projections indicate some areas of the globe will be cooler.

Given this level of uncertainty in predictions about global climate change, it is clear we need to continue the aggressive research program being supported by various Federal agencies to understand more fully the ramifications of increased greenhouse gas emissions in the atmosphere and potential impacts that could be caused by global climate change. In the meantime, we should embark, on measures to reduce greenhouse gas emission only if those measures also serve other policy objectives. That is precisely what the Administration has done.

ADMINISTRATION ACTIONS FOR ENERGY AND THE ENVIRONMENT

I would like to now summarize several initiatives undertaken by the Administration that address some of the objectives of S.324. Then I will describe our recent progress toward establishing a comprehensive research program in the areas of energy and global climate change, as well as mechanisms -- both national and international -- that we have developed for formulating informed policy decisions and for implementing these decisions. These actions, in my view, constitute an effective response to the goals that we all share.

The Administration considers it imperative that we continue to develop, in cooperation with the Congress, a well-designed program for research into the effects of greenhouse gas emissions on climate. We must also evaluate the economic and policy aspects of potential responses. Such a program will provide the foundation essential for the development of a

rational national energy policy that is economically and environmentally responsible.

I would also wish to emphasize the Administration's position that, pending the resolution of the significant scientific uncertainties surrounding climate change processes and their human and social impacts and concerns regarding economic and social dislocations stemming from efforts to limit fossil fuel use, our immediate focus should be on those actions that will reduce greenhouse gas emissions, but which can be fully justified for other reasons. For example, we have a commitment to phase out manufacturing and use of CFC's by the year 2000, ahead of the requirements of the current Montreal Protocol, provided safe substitutes exist -- these constitute 25 percent of our current greenhouse gas emissions. The Clean Air legislation currently under debate in the Congress will also provide substantial reduction in the emission of some of the greenhouse gases. A strong commitment to energy conservation is to be a major component of the Department of Energy's National Energy Strategy; and as an initial step in putting this strategy forward, the Department of Energy has already announced a series of conservation and renewable energy initiatives that are included in the President's FY 1991 budget request.

Turning from sources of these emissions to sinks, the Department of Agriculture's tree planting initiative (the planting of a billion trees on private land across America -- trees that could eventually absorb 13 million tons of carbon, annually) presented in the President's FY 1991 Budget, and our continued diplomatic discussions with countries such as Brazil aimed at protecting the remaining tropical forests, are key parts of our immediate response to this potential problem.

The Administration has already taken a number of additional steps that will enhance our understanding of, and response to, the potential effects of global climate change.

The President proposed in his FY 1991 Budget that funding for the U. S. Global Change Research Program be increased 57 percent over FY 1990, to $1.03 billion in FY 1991. The proposed funding would significantly expand research, data gathering, and modeling activities through a carefully balanced mix of ground-based and space-based research.

An underlying theme in all of the Administration's activities relative to potential climate change is that the strategy must be scientifically-based and technically and economically sound. It must also be dynamic -- responsive to new knowledge and ideas, and to global, environmental and international changes. A report on the wide ranging public hearings that represent a step in the process of formulating the National Energy Strategy, for example, has just been released.

FEDERAL RESEARCH POLICY AND COORDINATION

The Office of Science and Technology Policy is charged with reviewing and coordinating Federal R&D that cuts across the missions of more than one Federal agency, and with providing advice to the President on issues of science and technology policy that affect national and international policy. As Assistant to the President for Science and Technology and Director of OSTP, I chair two complementary councils -- one federal, FCCSET and one private sector, PCAST -- that provide information and advice. In addition, I chair working groups of the Economic Policy Council and the Domestic Policy Council related to science and technology issues. These groups, whose functioning I shall now describe, will accomplish the objectives -- and many more besides -- of the coordinating council proposed in S.324. Thus, the organizational changes proposed in S.324, I believe, are unnecessary. The establishment of a coordinating council proposed in S.324 would be duplicative and would not add significantly to the existing mechanisms.

S.324 also sets out specific R&D criteria that the propsed coordinating council is required to use as the basis for preparing "management plans" for the conduct of R&D in certain identified technologies. We do not believe the overly prescriptive nature of such an approach will be successful. The proposed approach does not adequately include the participation of the private sector technology developers and technology users. Most observers of R&D policy have found that successful government R&D occurs most frequently when the users or ultimate manufacturers of the technology are involved in the planning, conduct and testing of the applied technologies. S.324 does not provide adequate mechanisms for this critical private sector involvement.

Federal Coordinating Council for Science and Technology

The Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) was originally established in 1976 by Public Law

94-282, the National Science and Technology Policy Organization and Priorities Act, which also established the Office of Science and Technology Policy.

FCCSET is charged with providing more effective planning, coordination and administration of federal scientific and technological programs. This includes identifying research and development needs, and developing and reviewing in close cooperation with the Office of Management and Budget federal budget plans in cross-cutting areas of science and technology.

Research on global change is supported by a number of federal agencies and constitutes an exemplary case of common effort on a science policy issue. OSTP's coordinating function in global change research has been carried out largely through the Committee on Earth Sciences (CES), which is one of the committees under FCCSET.

The CES in turn has two subcommittees that deal with global change, the Working Group on Global Change, chaired by Robert Corell of the National Science Foundation, and a new Working Group on Adaptation and Mitigation Technologies, headed by John Knauss of the National Oceanic and Atmospheric Administration.

I would like to submit for the record a copy of the document "Our Changing Planet: The FY 1991 U.S. Global Change Research Program," which was developed by the CES Working Group on Global Change and which formed the basis for the President's FY 1991 budget request in this area.

The CES has integrated the efforts of the federal agencies conducting research on global change into the U.S. Global Change Research Program (USGCRP). The goal of the program is to reduce key scientific uncertainties and to develop more reliable scientific predictions upon which sound policy strategies and responses can be based. The CES expects to update the research plan annually and to change priorities as research results are obtained and as nonfederal groups provide input into the research process.

Among the many interesting and important science questions that need to be investigated, I would mention, in particular, the reliability of general circulation models, the earth's climatic history, the role of

clouds, oceanic influences on the atmosphere and climate, the hydrologic cycle, and changes in ecosystems.
This existing interagency coordinating mechanism is far preferable to the establishment of the committee directed in S.324, composed of directors of national laboratories who, after all, are contractors to the Department of Energy. In fact, the Committee on Earth Sciences, has done an excellent job in coordinating global change R&D. Having established an interagency process that works, it would be a mistake to replace it with a new mechanism which places contractors on an equal footing with cabinet agencies.

The President's Council of Advisors on Science and Technology

The President's Council of Advisors on Science and Technology (PCAST) was established by Executive Order of the President on January 19, 1990. The Council, which I chair, reports directly to the President and consists of 12 distinguished scientists and engineers from academia, industry, and other nonfederal institutions. This council provides an important ingredient that is missing from the FCCSET process -- views from outside the federal sector.

PCAST has already met twice with the President and his senior advisors. One of the topics discussed was global climate change, and I shall request PCAST to form a panel on environmental science and global change. This panel, with its private sector perspective, will complement the advice we receive from the CES subcommittee of FCCSET. The fact that I chair both FCCSET and PCAST insures good communications between the two groups.

The Domestic Policy Council Working Group on Global Change

President Bush also has asked me to chair a Cabinet-level Working Group on Global Change under the White House Domestic Policy Council. The Working Group provides Cabinet-level coordination on global change issues and is an important source of advice for the President.

The Working Group, when established last October, called immediately for three specific studies: (1) an analysis of economic costs of global change and responses to it, (2) an analysis of private sector concerns, activities, and issues on global change, and (3) legal precedents for international agreements and conventions on the environment.

Preliminary drafts of these reports have been presented to the Working Group for use in their deliberations. In addition, the Working Group has set up a number of briefings by top experts on the scientific, economic, environmental, and industrial aspects of global change.

Economic Policy Council Working Group on Science and Technology

Late last month an Economic Policy Council Working Group on Science and Technology was established to assist in formulation, coordination and implementation of Administration policies involving science and technology. The Working Group will also develop science and technology issues related to domestic and social policy for consideration by the Domestic Policy Council.

I will chair this Working Group, and members will include White House officials and senior representatives from all federal agencies and departments with substantial involvement in scientific and technological issues. This Working Group will analyze the scientific and technological components of economic and domestic policy issues.

INTERNATIONAL RESEARCH AND POLICY-MAKING MECHANISMS

Global climate change affects all nations and thus requires international study and cooperation. Within the international scientific community are a variety of informal mechanisms for planning science programs. Often these informal mechanisms are used to plan the detailed scientific elements of a more formal program, several elements of which are outlined below.

Conference on Science and Economics Research Related to Global Change

The President has asked me, together with the Chairman of the Council of Economic Advisers and the Chairman of the Council on Environmental Quality, to organize a White House meeting of the three senior officials in science, economics, and the environment from a number of countries. This White House Conference on Science and Economics Research Related to Global Change will take place in Washington, D.C. on April 17-18, 1990.

The conference will be devoted to science and economics research issues relevant to policy on global change, including climate. The Conference is designed to address important next steps that substantially enhance and broaden international understanding of science and economics research issues, and to frame initial steps toward a strategy for implementing joint international science and economics research efforts. It seeks for the first time to join research issues central to both the science and the economics related to global change.

Intergovernmental Panel on Climate Change

The U.S. government was instrumental in establishing and continues to support the work of the Intergovernmental Panel on Climate Change (IPCC), which is sponsored by the United Nations and the World Meteorological Organization. The three working groups of the IPCC, which are studying the scientific aspects of global change, impacts, and response and mitigation strategies, respectively, met here in Washington recently to prepare their reports. The final papers of the working groups will be presented to the full IPCC in August, shortly before the Second World Climate Conference in October.

In an address to the IPCC Plenary Session here in Washington, President Bush commended their activities and reaffirmed the United States' strong commitment to the IPCC process. He said, "We consider it vital that the community of nations be drawn together in an orderly, disciplined, rational way to review the history of our global environment, to assess the potential for future climate change, and to develop effective programs."

The IPCC process is designed to provide input to an International Framework Convention on global warming. At the Malta summit last December, President Bush proposed that the United States offer a venue for the first negotiating session for this Framework Convention, and he reiterated that offer at the IPCC meeting.

CONCLUSION

A National Energy Strategy is currently being developed by the Administration that will respect the environment, meet our nation's needs for energy, and not damage our economy or international competitive position. The Administration has already taken specific actions to begin dealing with the potential problem of global change by

taking the initiative on CFCs and Clean Air legislation that will have the effect of limiting greenhouse gas emissions. A vigorous structure of coordinating and advisory councils on global change is already in place and is functioning well.

Title I of the Act would unnecessarily duplicate, and thus complicate and hinder, aspects of both the National Energy Strategy planning process and the Executive branch committee structure we have just revitalized. I would have to oppose, in particular, formation of the proposed Federal Energy-Environmental Coordinating Council. More generally, I have a concern with requirements that would set goals or targets before we have reached agreement on how to evaluate total fuel cycle costs. Certainly, we should not do so unilaterally. These requirements could constrain our technical options, weaken our economy and threaten our competitive position with little environmental gain. The White House Conference later this month will begin to provide a basis for more considered actions.

Title II addresses energy efficiency. Increased efficiency and conservation are being closely considered in the formulation of the National Energy Strategy. The removal of market barriers to increased efficiency is relatively noncontroversial. Other steps to raise efficiency must be evaluated in light of their other impacts and benefits. The contribution of increased efficiency to lowering greenhouse gas emissions is clearly relevant. Our greenhouse gas emissions goals must ultimately be set with reference to the social and economic consequences of the actions required to attain them and those that would arise in a scenario where no such goals were adopted.

If significant greenhouse emission limitation over a relatively short time frame is ultimately judged to be desirable, increased efficiency alone will not suffice. In my considered opinion, massive fuel switching in our generation of electrical energy, greatly increased reliance on nuclear energy as well as other actions will be required. Consequently, to prepare for this possible policy direction, any long-term national energy plan should include research on advanced inherently-safe reactor concepts. These critical elements are missing from the Act. These very issues, however, are being addressed in a comprehensive fashion in the development of the National Energy Strategy and in the Intergovernmental Panel on Climate Change process.

Title III, in addressing energy research initiatives, would impose in several instances, detailed micromanagement that could be harmful to our development of an effective National Energy Strategy. I will defer to the Department of Energy for specific comments on individual technologies, many of which can play vitally important niche roles, but would again note my concern -- expressed above -- that research continue, with high priority, on advanced reactor concepts.

In summary, the Administration shares the Committee's commitment to address global climate change issues in a comprehensive manner based on sound environmental, economic and technical considerations. We believe, however, that the mechanisms currently in place are more than adequate to achieve this objective and we oppose the bill because many of its provisions are unnecessary, duplicative and overly prescriptive.

That concludes my prepared testimony. I would be happy to answer questions from the committee.

The CHAIRMAN. Dr. Bromley, thank you very much for a very instructive and interesting statement.

I am sure you are aware that this Committee has taken the lead in both seeking instruction and solutions for the problem of global warming or global change. We had our first hearings in 1987. The particularly dramatic hearings we held were in June of 1988 enveloped in 103 degree temperatures with an inversion and the noxious gases out there. The witnesses were sitting right there saying this is caused by global warming, by CO_2 in the air, and we have got to do something about it. I think everyone across the nation was alerted to the fact that we must respond.

Now, the first thing I want to do is elicit from you the state of changed knowledge since those hearings we held in the summer of 1988. As I recall, at that time there was if not consensus, then at least a broadly held view that there was a direct connection between what was called global warming at that time and greenhouse gases in the atmosphere. From your statement I gather your studies convinced you that there is not that direct correlation. There is much more uncertainty.

Is it fair to say that scientists in general hold to your view in that respect or is this a matter as to which there are still broad numbers of scientists who say that the global warming greenhouse gas connection is clear and convincing?

Dr. BROMLEY. This is a central question, Mr. Chairman. I think I can respond that there is a broad consensus throughout the scientific community on a number of things.

First of all, I think most scientists will agree that there is now evidence that over the last century the mean global temperature has increased by something like 0.5 degrees Celsius with an uncertainty of about perhaps 0.2 one way or the other.

The problem, however, is that there is also a consensus at this point—and this is different from the situation when you held your hearings—that it is not yet possible for us to unambiguously separate out an anthropogenic component of that warming from warming that would be part of a natural background change over this period.

The CHAIRMAN. Natural background being cities?

Dr. BROMLEY. No. The natural background, sir, predates cities and even humans by hundreds of thousands if not millions of years in simply natural processes that over time cause fluctuations, changes, some slow, some rapid, in the temperature.

The paleoecological data show this very clearly, and all of the measurements that we have, in fact, show even during this past century from 1880 to 1940 there was a slow increasing trend in the global temperature. From 1940 to 1965 there was a slow decrease. Then from 1965 to the present it has been increasing again, and we do not know whether that has anything directly to do with greenhouse gases or whether it is just part——

The CHAIRMAN. Of an ebb and flow.

Dr. BROMLEY [continuing]. Of a natural fluctuation in the background.

The CHAIRMAN. All right. When you are talking about the natural change, you do not mean necessarily a natural increase, but a natural ebb and flow which may be increasing at this time?

Dr. BROMLEY. Precisely, sir.

The CHAIRMAN. Now, as I recall from those measurements on the top of the mountain in Hawaii of greenhouse gases, which have been going on for how many years now?

Dr. BROMLEY. Since about 1957, sir.

The CHAIRMAN. That has been a rather linear increase in greenhouse gases, has it not?

Dr. BROMLEY. Yes.

The CHAIRMAN. Do the scientists predict a continued linear increase or does there come a point where saturation of CO_2 or other greenhouse gases would begin to absorb because of their level of concentration, absorb more rapidly?

Dr. BROMLEY. No. If the greenhouse—the second part of my answer to your first question—if we continue to pour greenhouse gases into the atmosphere at our present rate, I think you would again find a consensus among most of the nation's scientists that we will get warming. When the warming will occur——

The CHAIRMAN. No. I am not referring now to the question of warming. I am referring to the question of concentration in the atmosphere. In other words, does the level of greenhouse gases in the atmosphere affect the rate of their absorption? Might there be some ceiling there because of the level of concentration?

Dr. BROMLEY. I do not believe so, sir.

On the other hand, if you ask what about our own emissions from the United States then you do see not the continued increase that you pick up as the global average from Hawaii, but you see from somewhere in the mid-seventies our emissions have largely flattened off simply reflecting our reduction in the combustion of fossil fuels as a result of the oil shocks.

The CHAIRMAN. As I get from your statement, your opinion is clearly that it is not global warming or global change. Warming may or may not be part of that.

Dr. BROMLEY. That is right.

The CHAIRMAN. You were saying that there does seem to be a clear connection of warming?

Dr. BROMLEY. In the paleoecological data there is a close connection between temperature and the concentration of carbon dioxide in the atmosphere, yes.

The CHAIRMAN. But aside from paleoecological the new case studies show now a new estimate of warming for doubling of CO_2 dropped to 1.9 degrees Celsius down from the previous estimate of 5.2?

Dr. BROMLEY. That is correct.

The CHAIRMAN. Do you adhere to that new U.K. study that there is global warming though not as much?

Dr. BROMLEY. Within that particular model the prediction is for a lesser degree of warming, and let me emphasize, sir, that those calculations make the assumption that I mentioned in my testimony—that we hold everything else constant and we increase the amount of greenhouse gas by a factor of two and we ask what does the temperature look like under those conditions. Our models then do a point calculation now and a point calculation at the time we pick when we say that the gases will have doubled, and we have those two points.

There is nothing at all that says that we can interpolate between those two points. We may have large fluctuations, and we do not know how we would get from one to the other. We do not know how good the calculation of that 1.9 degrees would be for various reasons.

First of all, sir, because we are not treating the ocean atmosphere interface at all adequately; secondly, because the calculation to which you refer from the U.K. meteorological office (Mitchell and collaborators) only includes cloud effects in a rather unsophisticated fashion. It is a first try—it is a good try—but their next try could, in fact, reduce it further or could make the predicted increase larger. We do not know which way it would go. That is the kind of thing that has to be sorted out.

At the moment the best models that we have say that we are talking about something like—something between one and two degrees increased Celsius. Whenever we double the CO_2, if everything else is constant.

The CHAIRMAN. There are some scientists who say it might even cool, are there not, because of the cloud effects?

Dr. BROMLEY. They are perhaps in the tail of the distribution. Most people would not make that statement.

The CHAIRMAN. In other words, you and the vast majority do find that global warming is an expected effect of the greenhouse——

Dr. BROMLEY. Eventually.

The CHAIRMAN. That is a clear consensus of scientists?

Dr. BROMLEY. I believe that to be a clear consensus, sir.

The CHAIRMAN. And the things that we do not know are whether that warming is more of a change or more of a flat warming that might not drastically change?

Dr. BROMLEY. Let me try to make it very clear.

We believe, Senator, that we are going to see—suppose we forget the greenhouse gases altogether. Then the global temperature will change by the order of a degree from time to time without any greenhouse effect at all but rather from other feedback loops that are not being considered in our models. We just have observed that this happens.

On top of that the question is how much change can we anticipate from what we have done to the atmosphere. Our burden of greenhouse gases into the atmosphere is the biggest effect that our race has had on our planet in terms of sheer quantitative change to the planet, and so the question is, when will we begin to be able to detect an anthropogenic component in the temperature change unambiguously? When will it happen? In fact, when will the doubling of greenhouse gases happen? At what rate will the warming happen? How big will it be?

We cannot answer those questions, sir, with any certainty at all at this time.

The CHAIRMAN. Well, two years ago there were some models projected to us with maps of the United States predicting that there would be this creeping of the drier band, things would warm up, and Canada would become more productive, while the Midwest would dry up. Do you regard that as not valid now?

Dr. BROMLEY. I would say that most people would now believe that there is larger uncertainty in those predictions than was the case when they were presented to you.

The reasons are simple. The models that are used to make those predictions study points on a grid. They study the corners of grids which are roughly 150 miles to the side and at ten levels in the atmosphere.

When you have a grid that is 150 miles on the side, you average out the effects of things like mountains, the Gulf Stream, and rivers, and so we are not yet at a stage where we can predict with any sort of certainty regional phenomena. We do our best job averaging over the entire globe.

When you come to finer grids, it is going to require much more powerful computers, much more expensive computation and that lies in the future. But there is a second point, and that is in contrast to what you heard in 1988, it is much more recognized that if we get global warming and if vegetation patterns shift north, as you would expect that they might, if they have time to adjust—if the rate change is such that they can—then the fact is that we now realize from studies in the biological domain that the soils that these plants will encounter as they move north are much less attractive than those that they will be leaving and so that there will not be just a simple transfer of agricultural or other forest productivity if there is a northward or southward motion in either hemisphere.

The CHAIRMAN. The switch from global warming to global change underlines the uncertainty of the situation. And would you agree with me that the volatility of climate change is just about as frightening a phenomenon as just the warming? In other words, droughts in California, which we read about in the morning paper, increased hurricanes, floods, all of these phenomena are perhaps, although not predictable as to when and how and the extent of them, are a probable result of global climate change.

Dr. BROMLEY. If indeed we get global warming—if and when it comes—then one of the early symptoms of that warming that will be of greatest evidence to the public will be in terms of storm frequency and severity, possibly changes in precipitation patterns, soil moisture and so on. You are quite right, and frankly less effort has been devoted by far to studying the output side of the global change problem than the input.

We have largely concentrated so far on how big the warming might be, when it might happen, and so on, and not so much on what it might do and what the consequences might be.

It is for that reason that we have put together this new panel under the Committee on Earth Sciences to study mitigation and adaptation.

The CHAIRMAN. Let me hurry along. I apologize to my colleagues for taking so long, but you are too good a witness to let you go quickly.

Is there a saturation point of the greenhouse gases in the atmosphere?

Dr. BROMLEY. I do not believe so, sir.

The CHAIRMAN. So, that is the basis of your saying this could just literally increase?

Dr. BROMLEY. It would not go up linearly, but I do not see it saturating. Eventually perhaps when you get enough gas in the atmosphere so that it is opaque to infrared, then once it is opaque adding more gas is not going to affect much of anything; that is what has happened on the planet Venus, for example. But we have a long, long way to go before that happens here.

The CHAIRMAN. Dr. Bromley, I believe that we should take the steps that we propose here independently of global climate change or global warming. I think it is good energy policy, but what I am concerned about is if this is a serious global change that could result in all kinds of natural disasters. What could we really do to prevent it if we set our mind to do it? This calls for an answer of what is its cause in terms of the United States versus the world, and what is really preventable?

I have heard that animals produce a certain percentage of methane, rice growing produces it also. Could you give us a quick statement as to that?

Dr. BROMLEY. I am afraid that a quick statement on that question, sir, is almost impossible, but let me at least try to nibble at the edges of your question.

You are quite right that, for example, in the developed world one of the major problems in the greenhouse arena is the production and use of CFCs. We are working on that now effectively and the carbon dioxide from burning fossil fuels.

In the developing world one of the major problems is the emission of methane, and methane is a very potent greenhouse gas. It is important to recognize that a few decades ago we produced almost 50 percent of the globe's carbon dioxide. Now it is something under 25 percent, and probably by the end of the century it will be down to something like 12 percent.

The CHAIRMAN. That is not because we are going down. It is because they are going up?

Dr. BROMLEY. It is both. We are going down, and they are definitely going up. And obviously a great many of the developing nations, to further their development and their industrialization, will go up and will go up very rapidly.

The thing that is central to the answer I would give you, sir, is that there is very little that we as an individual nation can do that will have a dramatic impact on the global situation which emphasizes why we are working so actively to engage our fellow nations around the planet.

This is, I agree with you, sir, a serious problem that deserves serious consideration. I do not believe that there is any short-term disaster lurking out there, but I think the possibility of adverse effect is sufficiently real that it deserves our best efforts to figure out what we can about understanding what really is going to happen. That is going to take us quite some time.

In the meantime, we take out the insurance policy that we have all been discussing. I agree completely with you on the appropriateness of doing that.

The CHAIRMAN. So, it is not like King Canute trying to hold back the sea. We can really do something about greenhouse gases?

Dr. BROMLEY. Yes, and the most important thing we can do about it is convince our friends and neighbors in other countries that it is

in their interest to join with us in putting together a coherent, integrated international program of handling this problem.

The CHAIRMAN. Just one more question and then I will release you.

You state that this legislation is overly prescriptive and that it will be unsuccessful. How can the President's plan to establish a national energy strategy work without being prescriptive?

Dr. BROMLEY. Well, I think first of all there is obviously some degree of prescription involved in any successful federal policy, but I think that the great benefit that I see coming in the national energy strategy as I understand it from discussions with Secretary Watkins, Deputy Secretary Moore and their colleagues is that this is intended to be a dynamic document. It is something that will be revisited on a frequent basis and will change as we make progress in many of the areas that are outlined in the original version as our understanding improves as we get better understanding, for example, of the environmental impacts, and this will be a dynamic strategy.

That is why I believe they call it a strategy rather than a plan or a program. And my worry would be that if we were to box this in with legislation, it might inhibit this flexibility that I think is critically important if we are to get the most cost-effective response to the very real challenges that we have out there in the energy field.

The CHAIRMAN. You are almost persuaded but not yet.

Dr. Bromley, thank you very much.

Senator Wirth.

Senator WIRTH. Dr. Bromley, thank you very much for being here and for what I thought was excellent testimony. I really appreciate your very careful thought about this with which I very largely agree except the last discussion that you had with the Chairman.

I would like to, if I might, Mr. Chairman, also have included in the record some very good testimony that Dr. Bromley gave before the Budget Committee in February when we were discussing this issue as well and would ask that that be included at the appropriate point in the record.

The CHAIRMAN. Without objection.

[The material follows:]

EXCERPT OF PROCEEDINGS
U.S. Senate
Committee on the Budget

February 22, 1990

Senator Symms. Thank you, Mr. Chairman.

Dr. Bromley, thank you very much for all the enlightenment you have brought to this committee this morning. I received a correspondence from a constituent of mine, and this is a quote from Earl Dunkel, Phoenix Gazette, January 4, 1990, and he says there is a never-ending drumbeat of propaganda designed to keep people in terror of their environment, their lifestyle, their industry, their scientific progress; this propaganda, eagerly abetted by TV and the print media, covers every facet of modern life from global warming to acid rain, and et cetera.

Now he said to confront the foolishness, as I quote: "If you select any year but 1880, the coldest in our modern history, as a base, you get no global warming trend. In fact, the northern hemisphere has cooled since 1938 during the height of the carbon dioxide buildup."

Do you believe that is a true statement?

Dr. Bromley. Not quite. If we want to take a look at the U.S., for example, there was a very definite apparent warming trend which went from about 1880 to about 1940. Then it cooled from about 1940 to about 1970, and then the trend started back up, 1970 through the present time. And six of the ten hottest years in the century have occurred in the '80s.

Senator Symms. Then the next question is no statistically significant correlation exists between acid rain and acid lakes and waterways. Facts show soil chemistry, geology and land use to be the real culprits. Ironically, weather acidity is always greatest in areas where forests satisfy environmentalists by remaining uncut, unharvested and unburnt.

Now, we had some testimony before the Environment and Public Works Committee by a Mr. Mahoney--

Dr. Bromley. Yes.

Senator Symms. --and I believe he is either with EPA or with your shop, I am not sure. What are your comments on that statement?

Dr. Bromley. I agree that the point that your constituent makes is in general a well-taken one; that there has been scare publicity on many of these issues, and then particularly in the acid rain area, there have been media reports that vastly overstated the scale of the problem. But I think that there is no question that there is a hard core of fundamental scientific fact that does trace the emission of acid rain precursors from one area of the country to increased acidification on a very local basis in other areas. And we can trace that. We know what is happening.

But the problem is that just there, as in the global warming area, where no one is yet able to separate with certainty the changes that are naturally occurring in the planet and that have occurred for hundreds of thousands of years prior to the industrial age from those that are caused by our CO2 emissions.

The problem is that in these questions where the effect is not large enough to be clearly apparent, one finds very extreme positions. On the one hand, groups that say the sky is falling -- we have a tremendous crisis -- on the other hand, the ones who say forget it, that it is not important; it is not going to amount to anything.

My own view is that we have a responsibility in my office to try to provide the best science, the best economic analysis, the best fundamental basis for policy recommendations to the present on these subjects. And I find that more and more, we are working in the middle ground. For example in global warming, I think we would all agree that if we continue to pour greenhouse gases into the atmosphere at our present rate that eventually we would get global warming. When it would occur, we do not know. How big it would be and how rapidly, none of those things do we know with certainty at the moment. That is one of the reasons we need the models that Senator Wirth was talking about.

Senator Symms. What impact would the recent volcano, for example, that has taken place in Alaska--does that have any impact on--

Dr. Bromley. It would have nothing other than local effects, I believe. I do not think that the amount of emissions from that is really significant on a global scale.

But the important thing to emphasize, Senator, the thing that I think more than anything else has convinced the nations of the world that we have to take this whole question of global change seriously and address it in a responsible, calm fashion is the ozone hole.

Up until the demonstration of that hole, there was a widely shared perception among professionals and laymen alike that the atmosphere of the Earth was such a huge enterprise, if you will, that there probably was not much that Man could do to it, and certainly there was not anything that Man could do to it that would affect it on a short time scale.

What the ozone hole has demonstrated, and happily we now understand the science in detail for that one, is that Man's input to the atmosphere can have impacts, and it can be on a relatively instantaneous basis in terms of geological time scales. That is the thing that I think has brought this whole question to most people's attention; that we can affect our whole planet with what we do.

In this case, it was the CFCs. We now understand how they do the damage. We are committed in this country to completely ceasing both production and use of those CFCs before the Montreal Protocol requires it in the year 2000. That is 25 percent of our greenhouse gas, incidentally, as well.

And so, I happen to believe that we need to do several things. One, we have to understand as much as we can the underlying science and the economics, which up until very recently has not played much of a role in these discussions. But secondly, I think that there are a great many things that we as a Nation can and should be doing, if you will, as an insurance policy. (emphasis added)

While we figure out what is most probably going to happen, there are things that have other good reasons on their side, like the following. CFC reduction we should certainly do because of the ozone question. That cuts out 25 percent of our greenhouse emissions right there. We should certainly focus on using energy more efficiently. There is no way that we have technology at the moment that you can burn fossil fuels and not generate carbon dioxide. So if you want to limit the amount of carbon dioxide, you have to use less fossil fuel, which means you have got to use electricity more efficiently.

Now, Admiral Watkins and the Department of Energy are moving aggressively to develop a national energy strategy that does that. I think also that we have to look forward to reforestation. The President has proposed an ambitious program there through the Department of Agriculture that will act as a sink for CO2. Again, an insurance policy for something we should be doing anyway. The Clean Air legislation would have a dramatic impact on reducing our greenhouse emissions. And finally, I believe that it is important for us to maintain our diplomatic initiatives with countries like Brazil, to try to work out an arrangement that will keep those tropical rainforests that are a unique heritage for all of mankind, not just because of what they do to carbon dioxide, but because they contain some 80 percent of the uncharacterized lifeforms on this planet. And if we truly believe, as we do, that biodiversity is critically important in terms of the generations of new

pharmaceuticals, new antibiotics, new plant species, new everything, we have to protect that gene pool that is being destroyed at a rate at present that would eliminate it completely in less than 20 years.

Chairman Sasser. Dr. Bromley, I am going to have to leave you and go to the Banking Committee. I think Senator Wirth may have an additional question or may wish to chat with you here.

Am I correct in that, Senator Wirth?

Senator Wirth. That is correct, Mr. Chairman.

Chairman Sasser. Well, in that case, Senator Wirth, I will leave this committee in your charge, and I am going to--

Senator Wirth. [presiding.] Thank you, Mr. Chairman.

Let me jump back to some of our earlier discussion, taking it away from the parochial to the more general, if I might. I thought your statement on global change and what we ought to be doing was absolutely terrific. The insurance policy analog, I think, is a very good one and one that ought to be used.

Just three quick points that you did not touch upon; first of all, when you talked about energy efficiency, it seems to me we have a job. Now we know a lot about energy efficiency technologies, particularly in buildings -- you know, light bulbs and lighting standards, insulation, new windows and doors -- and there is a very big target right in the area of commercializing what we know in energy efficiency.

And the question is; how far does the government go in trying to pool and encourage that technology? One of the things that we ought to be talking about -- there are enormous savings that our society -- you are familiar with the numbers of our energy and efficiency. Do we have a job to help do some commercialization?

Dr. Bromley. I think we do. I think first of all that these points you have just raised are going to figure very strongly in Adimral Watkins new energy strategy. And I think that, for example, we in the Federal Government could go a long way here by simply practicing what we are preaching, too-

Senator Wirth. Oh, yes.

Dr. Bromley. --and demonstrating in our own establishments nationwide just what can be done in this area. And even going beyond the things you have mentioned, in areas that have been passed by, like electric motors -- when the President's Council met two weeks age, David Packard, who has been involved in high technology for a long time, emphasized the point that we tend to think of the electric motor as something that, you know, "Well, there it is. It is

marvelous and it is enormous, efficient, and you do not muck about with it."

But even there, if you can gain a few percent in efficiency, as we can with modern technology, and install that -- when you consider the millions and billions of motors that we have, it is just indicative of the fact that we have a tremendous opportunity to increase our efficiency of utilization of electricity in almost every area you can think of in this country.

Senator Wirth. And the easiest target is probably building standards; more controversial is transportation, but that is also one that is just crying out for greater efficiency.

Dr. Bromley. And there is a third one, sir, that I think we have to keep in mind that we frequently forget, and that is in industrial processes. When those processes were developed in this country, as contrasted to Japan or Western Europe, when you wrote down the equation to optimize your process for your factory, and you put down raw materials and labor and transportation and all those good things, in the U.S., we never had a term for energy because we assumed it would be available and cheap. Everybody else had a term for energy with a big coefficient. And so, if we made just those changes as is possible, amortizing the big capital investments involved, we could make still a major increase in our effectiveness of energy utilization.

Senator Wirth. A couple of other points, and I know that you have to go. You did not mention alternative energy programs on your laundry list of what were the elements of a good insurance policy.

Dr. Bromley. I would very much like to pick that one up, sir. I think that we have a very real responsibility there. There are many levels to the alternative energy question. First of all, we can address what I would call niche energy sources, sources that are particularly good in a particular area. Those include, in my view, solar energy, geothermal energy, ocean thermal gradient energy, wind energy and so on.

But when you talk about major blocks of electrical energy -- if we are really going to cut into that 50 percent of our greenhouse emission, that CO2, you have got to stop burning fossil fuels in big electrical generating plants. And the only technology that we have at the moment that can pick up that load without the CO2 burden is the nuclear option. And I believe that we have to essentially start from scratch if we are going to make that a viable alternative in this Nation; and that means that we have to go back and get modular designs that are intrinsically safe, that you could walk away from and have--

Senator Wirth. Passive, I think is the word.

Dr. Bromley. Pardon?

Senator Wirth. Passive.

Dr. Bromley. Passive. There are a variety of good words. In fact, the big one is called PIUS.

Senator Wirth. PIUS.

Dr. Bromley. It all has the right significance. But the idea is that if you turn off everything and if lightning strikes in the immediate vicinity, nothing will happen. And the nice thing, Senator, is that during this past six months in Germany, for example, a modular, high-temperature, gas-cooled reactor did have all its coolant gas released and all its cooling water turned off, and it neatly closed itself down, as it was supposed to. It was a very good demonstration which has not been much publicized in this country.

But I believe that so many of us, and I am one of them, in the nuclear industry as it has been in this country have not done the things we should have done to inform our public of the true disadvantages and advantages that we are faced with what is almost an irrational objection to nuclear energy.

Senator Wirth. You are right. I agree with what you have said. There is, as you know, a growing nuclear neuralgia in the country, and as that grows, we do have to start all over again, and I think start all over again technically and start all over again politically, and to really focus on the issues of waste disposal, nonproliferation and so on that are going to be necessary and that you point out.

Two other very quick points, and I know you have to run. One of the elements that we have to do, I think, a great deal more work on is understanding our own globe. We are spending about, as I understand this year, $150 million on genetic research to understand our own, I guess it is called the human genome, is not that right?

Dr. Bromley. Yes, the human genome.

Senator Wirth. And on the other hand, we know remarkably little about the thousands of species that we are losing every year, I think, in the nature of maybe 10,000 of more. E.O. Wilson, whom you know, I had breakfast with the other day. And he suggested what we ought to have is a prospecting expedition, or, he said, like Mission to Earth in some ways. But really bring it right down, to start by mapping the biological resources of the would and start there, as well. And in the process of doing so, understanding what the commercial value of that was so we can explain to people what the enormous loss is that is going on out there. And there is almost nothing going on in terms of our support of that particular kind of research.

We can measure the distance to the moon down to, I understand, centimeters, but we do not know down to millions the number of species that are right in our own backyard; sort of, again, one of these anomalous situations, to use anomaly again as a word.

Dr. Bromley. I could not agree with you more, sir. And I think that these are all areas that we have to work with. I would only raise one problem that you and your colleagues here in the Congress are really going to have to help us on, and that is the fact that a growing number of the countries where the tropical forests are have come to resent our mining expeditions for their gene pools because they suspect that what we will do is bring them back, use them to create products that we will then sell back to them at outrageous profits.

So we have to do something to make it obviously in their best interests as well as ours.

Senator Wirth. When I was in Brazil, President Sarney said to me about the Amazon; he said, "I do not want this to become a green Persian Gulf." It was sort of the same thing.

Final item, population. You did not mention in your notes from Chairman Bromley on global warming and the state of the globe; you did not mention population. Let me just ask you to comment in the way that you think would be appropriate on the issue of population, population growth and how that relates to global warming and all of the other issues that you have been talking about.

Dr. Bromley. I have always viewed the uncontrolled population growth planet-wide as one of the long-range but yet very serious problems that we as a global civilization must learn to cope with, for several reasons. One, because in the very far distant future, we run into just the simple thermodynamic problem of too many people. But that is a long way away.

The thing that concerns me most is that the gross disparity between the quality of life enjoyed by us and enjoyed by a great many people in other parts of the world where their population growth rates are such as to condemn them to a continuation of those totally unacceptable standards of living.

And now that we have indeed become a global village from the communications point of view, for the first time in the history of the planet, they are beginning to see and perceive just how different their lives are from ours. And it is my belief that unless we do something about this, unless we are perceived to be doing something about this, we face a world in turmoil.

Senator Wirth. Therefore?

Dr. Bromley. Therefore, I believe that we have a responsibility to provide assistance nationally, and globally in this area of population control.

Senator Wirth. Well, I think that that is exactly correct. Unfortunately, the contributions of the United States have not only leveled off, but our percentage of the contribution to the world-wide program has declined very dramatically under pressure from particular groups, and this has had just the opposite effect of what they wanted to do.

I think we have incurred by dramatically cutting our population family planning support programs around the world -- we have occasioned a very sharp increase, for example in abortions around the world. And that is just the opposite of what the groups opposing family programs have wanted to have happen. And I think we have got to work with them and also work with the Congress to understand that the most humane way in which we can assure the quality of life that you speak to and take care of the special problems that those groups are concerned about is for the United States to once again resume the leadership role that we had for a long time in international family planning programs.

And I hope that we can move in that direction. President Bush used to be a very strong supporter of program along this line. I do not know where he is now in terms of international programs on family planning, but maybe we can get the administration back in harness and have the United States be the lead that we once were proudly around the world.

Dr. Bromley, we really appreciate your being here today, and kept you seven minutes beyond your time. Normally the Congress, as you know, runs on time and within the budget, and we are sorry to keep you seven minutes late, but we appreciate you being here.

Dr. Bromley. Thank you, sir.

Senator WIRTH. The consensus, if I could summarize that, would appear to be that if we continue to pour greenhouse gases into the atmosphere, the globe will warm. That is the broad consensus in the scientific community.

Dr. BROMLEY. I believe so, sir.

Senator WIRTH. What does the data show over the 160,000 years in terms of the increase in carbon dioxide in the atmosphere, the ice core drillings that you were talking about earlier? What does that show?

Dr. BROMLEY. It shows that over that period as we move from one glaciation through to the next that we had temperature swings of the order of 10 degrees centigrade and that the carbon dioxide content in the atmosphere as measured in those core bubbles tracked the temperature profile over that period with considerable precision.

Senator WIRTH. But as there was more carbon dioxide in the atmosphere over this period of time, the earth got warmer and less carbon dioxide, the earth was cooler?

Dr. BROMLEY. That is correct, and the same thing is true with methane.

Senator WIRTH. What do those core drillings show us about what has happened since the industrial revolution in terms of the loading of carbon dioxide?

Dr. BROMLEY. Since the industrial revolution the cores do not show us essentially anything.

Senator WIRTH. What does the data overall show?

Dr. BROMLEY. The data overall show that, for example, in carbon dioxide to take that specific one, that we have increased the burden in the atmosphere by about 25 percent averaged globally. Methane has increased by a significantly greater factor and is increasing almost exponentially at the present time.

Senator WIRTH. Has there ever been as high a loading of carbon dioxide in the atmosphere as there is today?

Dr. BROMLEY. Roughly—yes, there have been times. I have forgotten the exact time, Senator. I would have to go back and look at the ice core data, but we have had close to our present value.

Senator WIRTH. Not as high, though? Our present value is higher than it has been before?

Dr. BROMLEY. I believe that our present value is slightly higher than the highest peak on our record, but not dramatically so.

Senator WIRTH. And if we then follow the patterns that we are currently in or follow the current trends, particularly looking at, say, industrial development elsewhere in the world, which is patterned in China, and it increased dramatically, we can then anticipate the carbon dioxide loadings are going to increase pretty sharply.

Dr. BROMLEY. Yes.

Senator WIRTH. And, as you pointed out, the data in the United States that we had as a result of the Arab oil boycott and energy efficiencies, show that we had a leveling off of U.S. contributions although the U.S. contributions today are about 25 percent of the total world loadings in the atmosphere. So, we with a small percentage of the population are putting a lot of the carbon dioxide up there?

Dr. BROMLEY. That is correct.

Senator WIRTH. There is no disagreement about that?

Dr. BROMLEY. None.

Senator WIRTH. And is there not evidence now that in the last couple of years the U.S. consumption of energy, particularly fossil fuels after leveling off for a period of time is now starting to move back up again?

Dr. BROMLEY. That I believe is the current evidence, sir.

Senator WIRTH. And so if the U.S. starts to increase, we have a disproportionate addition to the atmosphere, do we not, because we have such a very large part of the contribution in carbon dioxide?

Dr. BROMLEY. I think perhaps you could not make that assumption safely, sir, because the rate of growth of carbon dioxide emissions—particularly from the developing world and very probably we can extrapolate the same in Eastern Europe in the next few years—will be vastly greater than the rate of increase in the U.S.

Senator WIRTH. Is there evidence now that shows that our increase, however, is above the world increase, that the addition in carbon dioxide from the United States is lower than that of the world increase now?

Dr. BROMLEY. My understanding, sir, is our increment of increase to the atmosphere at the moment annually is less than the increment that comes from outside the U.S.

Senator WIRTH. We are still 25 percent of that of the world?

Dr. BROMLEY. That is correct.

Senator WIRTH. When you and Mr. Reilly went to the Netherlands conference, you signed on to that agreement that we were going to attempt to stabilize the loadings of carbon dioxide?

Dr. BROMLEY. It was a consensus document, sir. We did not sign it.

Senator WIRTH. The U.S. did not sign it?

Dr. BROMLEY. Nobody did. It was simply a chairman's consensus document. But we did, in fact, join with our colleagues from other countries on that occasion in agreeing that it was desirable to stabilize greenhouse gas emissions.

Senator WIRTH. Now, in order to stabilize those, we then get into a discussion of the insurance policy, right?

Dr. BROMLEY. Yes.

Senator WIRTH. And that is where you were very eloquent at the Budget Committee and again in less time this morning in talking about what ought to be in an insurance policy to stabilize greenhouse gas emissions.

Dr. BROMLEY. Yes.

Senator WIRTH. And that, you think, should be the policy we ought to be following?

Dr. BROMLEY. I believe that we have at least the possibility of achieving stabilization by doing things for which I believe we have excellent other reasons, and I think we should get on with this as fast as possible.

Senator WIRTH. So, there is consensus that if we continue to load greenhouse gases into the atmosphere the world will get warmer?

Dr. BROMLEY. If the world continues to load them at its present rate, it will get warmer.

Senator WIRTH. And do those current trends look like they are certainly heading in that direction from everything we see from the data?

Dr. BROMLEY. That is correct.

Senator WIRTH. We are increasing, the world may be increasing more rapidly than we are?

Dr. BROMLEY. What we do not know, sir, is when that will happen and how big the effect will be, and we do not know whether, while this is going on as a result of anthropogenic phenomena if Mother Nature were to turn around and decide she was turning down the temperature, it is hard to predict what the net effect would be adding anthropogenic to natural phenomena.

Senator WIRTH. Have you walked through this with the President and with Mr. Sununu.

Dr. BROMLEY. Yes. We have done this. This was part, for example, of the discussions that we had with the President and Mr. Sununu at our Camp David meeting.

Senator WIRTH. And do they agree with you that the evidence is, if we continue to put these greenhouse gases into the atmosphere, the world is going to get warmer?

Dr. BROMLEY. I do not think there is any question about the eventual result. It is a question of when, how much, and what is happening to the natural background.

What we really are saying, and I should really be very precise about this, I think the scientific consensus is that if we continue to load the atmosphere with greenhouse gases, then we will eventually find an anthropogenic component of the planet's temperature, which will be discernable, and which will be increasing. But we cannot tell you what the background will be doing. And so we do not know what the total will be.

Senator WIRTH. But the evidence would suggest, going back over 100,000 years, that there has never been a time where carbon dioxide was higher than it is today?

Dr. BROMLEY. That is correct. But the temperature has fluctuated by some 10 degrees over that period.

Senator WIRTH. But that is only when carbon dioxide was decreasing, you were saying earlier, right?

Dr. BROMLEY. Yes.

Senator WIRTH. So we can assume that if we follow current trends, the chances that carbon dioxide is going to decrease are pretty slim, and that temperatures are going to go down?

Dr. BROMLEY. Let me again try to make it clear. The best models we have at the moment, remember, Senator, are telling us that if you double the carbon dioxide, and there is considerable debate as to when that is going to happen, whether it is 50 years or 300 years is now very much a matter of debate, but the best models predict that if you double the carbon dioxide in the atmosphere, then you are talking about something between one and two degrees of increase due to that doubling.

Now if, at the same time, nature had decided to reduce the temperature of the planet by two degrees, then what would happen would be that the whole globe would be one degree centigrade cooler than it is now.

Senator WIRTH. Is there any evidence that nature has ever turned down the temperature when carbon dioxide was going up?

Dr. BROMLEY. Yes, absolutely. On top of the big glaciation, 10-degree swings that you see in the ice core data, if you expand that data to look at its fine structure, there are periods where you get the kind of oscillation that I have just been talking about, superimposed on the major glaciation swings.

The CHAIRMAN. Would the Senator yield at this point?

Is there a consensus as to whether this cause/effect relationship between CO_2, as measured in glaciation, and temperature change, as measured by the same way, which was the cause and which was the effect?

Dr. BROMLEY. That is an extraordinarily good question. There are some people who now will tell you that from very precise studies of the data, that they can pick out of that data the CO_2 leading the temperature by somewhere between 35 and 75 years. But that is by no means an agreed upon result. It is a very preliminary result. And, in fact, I have not seen it published yet, but I know that it exists.

That is an area which requires very serious work. Because that is a vitally important question. Does the carbon dioxide lead or follow the temperature? And I can only tell you, sir, at the moment there are rumors of measurements that say that the carbon dioxide leads and therefore is causing the temperature change. But that is not yet a scientific result that has been published or peer reviewed or generally accepted.

Senator WIRTH. Let me see if I understand, again, going back to the carbon dioxide. Are there times when carbon dioxide in the atmosphere, under the core drillings and that evidence, that the carbon dioxide has increased, but the temperature has been going down?

Dr. BROMLEY. Yes.

Senator WIRTH. What else was going on that we know about?

Dr. BROMLEY. We have no idea.

Senator WIRTH. You do not know.

Dr. BROMLEY. This is fine structure on the gross behavior we measure, and the data are not sufficiently good to really tell us what is happening. But let me tell you one thing that is important to understand. If you look at these core data closely, you will find that the temperature rate of change is different in the warming and in the cooling.

And what this is suggesting to many people is that the circulation in the Earth's oceans has at least two stable configurations, and that it is relatively easy to trigger a change, which might, for example, eliminate the Gulf Stream.

And once you are able to do that, because of the much greater energy content of the oceans and carbon dioxide content of the oceans, then you can have a sort of flip-flop effect. There is growing evidence that major changes in the circulation in both the atmosphere and in the ocean can take place over a relatively short period.

That, again, is an area that badly needs research. We just have hints of what is happening.

Senator FORD. Mr. Chairman, I am not as smart as these people here, and things kind of get away from me. You use words and terms that, to a country boy, are awful hard to follow. [Laughter.]

But you are talking about oceans and atmosphere and all that, and NOAA just the other day I think gave a report on five southeastern states, the Carolinas, Florida, Georgia and Alabama. And you say we are not treating the oceans right, but temperature has been observed in those five states now, since 1895. Am I correct?

Dr. BROMLEY. Yes.

Senator FORD. And the temperature has gone down?

Dr. BROMLEY. Yes.

Senator FORD. Now, it has not risen, but is has dropped. Now, you tell me why. You know, you worry about the oceans and what it does and the atmosphere and what it does, but we have been observing this now for 95 years and the temperature has gone down.

You know, a country boy needs that explained to him. [Laughter.]

Dr. BROMLEY. Well, Senator, a lot of us country boys need that explained to us. [Laughter.]

Senator FORD. Try four-letter words, Dr. Bromley. [Laughter.]

Dr. BROMLEY. Let me try, sir.

First of all, the land area of the United States corresponds to 3 percent of the total area of the planet. And so what happens in a small piece of the United States can happen rather dramatically without affecting the average over the other 97 percent.

That is the first point.

The second thing is that all of our models, even the crude ones we have now, make it clear that there can be regional effects that are way off any average that we talk about. And we simply, sir, at this point, do not have either the data or the mathematical sophistication or the computer power to really do the kind of calculation that allows us to say with any sort of certainty what is going to happen to your region of the United States.

Senator FORD. But we know for 95 years of checking the temperature and observing the temperature that it has declined.

Dr. BROMLEY. Right.

But the fact, sir, is that in taking the temperature data from all around the world—and I admit that a lot of it is not of very high quality——

Senator FORD. Well, why use low-quality stuff? We have been doing that for a long time. That is the reason we are in trouble.

Dr. BROMLEY. Let me tell you. Us country boys really will understand this one. I, too, am one.

In the old days, the way they measured the temperature was they dropped a canvas bag over the side and they lifted it up full of seawater, and then it sat around for a while on the deck until someone got around to figuring out how the hell the thermometer worked. And during that time there was evaporation from the side of the bucket, which could change the temperature of the water in the bucket by a number of degrees.

And so, the people who work in this field have to be incredibly ingenious, on the one hand, to go back and figure out on the average how long did the sailor look at the bucket before he really got

the temperature measurement. These are the relatively unsophisticated ones.

The other guys are the ones who worked in the middle of what is now a large city; they started taking measurements, some of the measurements you yourself just referred to, back in the late 1800s. These were taken in relatively small towns that have subsequently grown to be very large cities. And there are heat island effects around those cities that change the temperature.

If you take the temperature measured in the same spot every morning for X hundred years, one of the real difficult things that we have to correct for is what humans have been doing around that point during that period—because that can swing the temperature quite dramatically.

I am just mentioning this to emphasize how difficult it is to get reliable data.

Senator FORD. I would say if they had left that bucket out in the sun for a while, the temperature would have gone up.

Dr. BROMLEY. Most sailors have a tendency, sir, to hide in the shade, I think. [Laughter.]

Senator FORD. There is not much out there.

Dr. BROMLEY. But there is a breakthrough that you should know about, gentlemen—a breakthrough that was reported in Science magazine that just came out this week. It is a NASA document, and the authors have measured, for the last decade, over the United States with satellites, and have compared the temperature measurements obtained high enough in the atmosphere so they are not affected by city heat bumps and whatnot.

Although this was reported in the media as saying that there is no greenhouse warming because they did not detect any systematic warming. (The northern hemisphere warmed up a little bit, and the southern cooled a little bit, so the average was about a wash.) the key, important thing from the measurement is not that at all. What is crucial is that they have demonstrated—for the first time—that from satellites you can measure, with precision of one-hundredth of a degree centigrade, what the temperature is anywhere on the Earth's surface.

And so with a couple of a satellite passes, we can get better data now than has ever been obtained before over that 97 percent that simply was not available to us with any sort of precision before.

The CHAIRMAN. Was that infrared?

Dr. BROMLEY. They did it in a number of wavelength bands, Senator, to try and be sure that they could eliminate as much of the interference as possible, and so they picked a number of wavelength ranges. The so-called T2 range is the most sensitive.

The CHAIRMAN. Let me see if I understand. They can tell the temperature on 97 percent of the earth's surface?

Dr. BROMLEY. On 100 percent, and they can do it to something approaching 1/100 of a degree centigrade. Not only can they measure the earth's surface, but they can measure at various slices in the atmosphere.

The CHAIRMAN. How new is this technology?

Dr. BROMLEY. The paper was just published this week. It is NASA data.

The CHAIRMAN. Would this not be an incredible breakthrough for weather prediction?

Dr. BROMLEY. It would be an incredible breakthrough for weather prediction if we had, models that had a small enough grid size so that we could, give you regional and local predictions. This is the Holy Grail in this whole field. It is what NCAR, in Senator Wirth's district, for example, are desperately trying to achieve and are currently trying to work on. So are many other national centers around the globe.

What it means, however, to reduce the size of the grid from 150 miles to 60 miles is a factor of roughly 500 in computer speed and capacity and roughly a factor of 500 in cost per run.

And so once those computers are in place, then we can begin to give long-term weather prediction with some reliability.

The CHAIRMAN. Can it predict ocean surface temperature?

Dr. BROMLEY. Yes.

The CHAIRMAN. But it cannot go down below the surface of the ocean?

Dr. BROMLEY. No. Well, not very much. It depends how far you can penetrate.

The CHAIRMAN. And this is a rather sudden breakthrough?

Dr. BROMLEY. Well, they are data that have been accumulating over the last decade, but have only been analyzed in the recent past. We had felt—all of us, I think, in the community had felt—that the detectors that we sent up in these satellites would tend to drift rather badly. They would be hard to calibrate. We could not believe what they told us about temperature.

This particular set of measurements, for the first time, were able to compare what we measured from the satellite with what we measured on the ground, and the agreement was excellent.

Senator WIRTH. Mr. Chairman, let me go back if I might just to understanding this 160,000 year trends and greenhouse gases. You were saying there have been times when greenhouse gases were increased but temperature went down?

Dr. BROMLEY. That is correct. I do not know if you can see from there, Senator, but if you take a diagram like this, you notice that there is large structure. There the correlation, carbon dioxide up, temperature up. But if you look at the fine structure, there are many places over the periods of tens of thousands of years where you have the opposite correlation.

Senator WIRTH. The amount of greenhouse gases are 55 percent carbon dioxide, is that right?

Dr. BROMLEY. In the atmosphere?

Senator WIRTH. In the atmosphere now, that we are putting in the atmosphere now.

Dr. BROMLEY. In the United States carbon dioxide constitutes about 57 percent of our greenhouse gas emissions.

Senator WIRTH. And worldwide what is it?

Dr. BROMLEY. I do not know the figure worldwide. I am sure it is probably greater worldwide.

Senator WIRTH. And the other greenhouse gases that we are putting in, the chlorofluorocarbons?

Dr. BROMLEY. The chlorofluorocarbons are extremely potent. So also is methane and so also is nitrous oxide.

Senator WIRTH. And the chlorofluorocarbons are clearly all a result of man's activities?

Dr. BROMLEY. That is correct.

Senator WIRTH. And how about the others?

Dr. BROMLEY. In carbon dioxide—in the normal flow of carbon dioxide in the atmosphere right at the moment, the manmade part is somewhere between one tenth and one twentieth of the natural flow.

Senator WIRTH. And how about methane and nitrous oxide?

Dr. BROMLEY. I do not think anybody knows with any sort of precision—methane we know that the major sources of methane are termite colonies, rice paddies and cows with indigestion.

Senator WIRTH. Let me go on to the insurance policy briefly. You listed a variety of items in the insurance policy and talked about forestation policy that the President announced a program for planting a lot of trees. Have you discussed this with the Secretary of Agriculture, Secretary Yeutter?

Dr. BROMLEY. I have talked with Secretary Yeutter about it, but not in any great detail.

Senator WIRTH. Now, will you be talking to them about the agriculture—this is not our jurisdiction, but sort of a sidebar on this. Will you be talking to them about it what our policy ought to be related to what our first policy ought to be as to how the impact that that might have on global climate change?

Dr. BROMLEY. Secretary Yeutter, for example, is a member of the DP working group on global change that I chair, and he is very much involved in these discussions.

Senator WIRTH. Presumably one of the items in your insurance policy is forestation and reforestation. One ought to be less deforestation. That would be the other side of that, and we would appear to have a responsibility in the United States to look through, perhaps something of a different lens at policies that we are currently following relating to forestation and our use of the national forests and so on.

Dr. BROMLEY. Fortunately Secretary Lujan is also member of the working group.

Senator WIRTH. Would that argue that we ought to be doing less clear cutting, that we ought to be tending to growing more trees rather than fewer on federal lands?

Dr. BROMLEY. Although my family has spent many generations in the lumbering business, I think I have gotten far enough away from it that I would not be in a position to give you an adequate answer.

Senator WIRTH. You are getting to be a very good politician in the few months there.

Let me ask you, another part of the insurance policy would presumably be population, would it not?

Dr. BROMLEY. There is no question, sir.

Senator WIRTH. As part of that we ought to address developing an aggressive population policy worldwide.

Dr. BROMLEY. It is my conviction—and I have written widely on it—that one of the most serious problems we face in this whole area is that of population control.

Senator WIRTH. What would be the ingredients? What would be the subgroups of population policy as part of an insurance policy? What kind of things should we be doing?

Dr. BROMLEY. I believe that we have a responsibility and an opportunity to assist the areas of the world where we have very high birth rates to slow those birth rates down to a level where they could be self-sustaining.

Senator WIRTH. And how do we go about doing that?

Dr. BROMLEY. I am not an expert at all in that area, sir. There are those involved in the biological sciences and involved in AID, for example, who are working these problems. My Associate Director for Life Sciences is very actively interested in this.

I myself am not sufficiently expert to give you a good answer.

Senator WIRTH. A very final, very specific question. You mentioned in your discussion with Senator Ford about looking at variations and trying to understand this enormous amount of data. You mentioned the need for very sophisticated and high powered computer capability.

Dr. BROMLEY. Yes.

Senator WIRTH. Is that something we currently have in the atmospheric sciences?

Dr. BROMLEY. No, we do not. We have very high powered computer equipment compared to the rest of the world, but we do not have the kind of equipment that would allow us to extract from the data we now have information that would be extremely useful to us.

Senator WIRTH. Is that capability available? Do we have that in Crays for example or Crays side by side? Is that the kind of capability that we are talking about?

Dr. BROMLEY. The capability is under development I think is the right way to phrase it, that the next generation of supercomputers, two kinds: first, the large mainframe is being developed by Cray and other mainframe companies and should be available, I understand, within a matter of one or two years. And in parallel—I did not mean to say that—but massively parallel architectures are also under development that would, I am told, produce terra-ops, trillions of operations per second by about 1992. So the two paths, the large mainframes and the massively parallel units are coming along together.

The weakness, quite frankly, is not so much in the hardware as in the software to use these new very powerful supercomputers.

Senator WIRTH. Before we get to that level of the very powerful supercomputers, what is the next level?

Dr. BROMLEY. The atmospheric science folks have the best computers that are available, given modern technology. Usually they do not have as many of them as we they would like or believe they could use.

Senator WIRTH. Well, it seems to me that given the numbers crunching that you were talking about and the need to try to understand all of this data and begin to model it in a more sophisticated way that that would be a priority that we ought to be pursuing. That would be a relatively small investment I would think given the overall area that we want to better understand.

Dr. BROMLEY. I agree with you, sir, and I am happy to tell you that my office last fall issued a report on High Performance Com-

puting to the Congress. We emphasized that that was a four point program; first to develop the supercomputers, and to develop a viable domestic market that would allow those companies to continue in a viable state; secondly to develop a national, broad-band fiber optic network that would make the power of those computers available to a vastly larger fraction of our people than is now the case; thirdly to develop user-friendly software for them because now these machines are used by nuclear weaponeers and by global climate modeling folk, and the one thing you can say about the software is that it sure is not friendly. If we want other people to start using it, we are going to have to put a lot of work into the software.

And, lastly, we have got to be careful because we already have a shortage of people in this country trained to use this kind of computational facility and, as we mentioned in the other hearing, to which you referred, one of the more depressing statistics in an already appalling educational system in this country is the fact that when freshmen entering the nation's universities and colleges last fall were asked about their interest, we found a rather remarkable result that in the last ten years interest in physics and chemistry and all the other brand name sciences has decreased by about a third. Interest in mathematics, I am sorry to say, has gone down a quarter in the last seven years, and interest in computer science has dropped by two-thirds in the last four years.

This is a rather direct indictment of the quality of our pre-college education, and it also is a warning that we face a very serious problem in terms of having adequate trained manpower in this nation to do the things that we consider important.

Senator WIRTH. Did the administration request funding for this computer capability and the computer science training capability in this budget?

Dr. BROMLEY. There is about $469 million across the agencies in the fiscal year 1991 budget. My office has already pulled together a group of senior people from all the agencies because I am concerned that we are not moving as rapidly as we might, and I hope we can get some reprogramming in 1991 and by 1992 it is my expectation that we will have, under FCCSET, a committee fully functioning that will allow us to bring to OMB, and to the President, a completely integrated program in high performance computing because I think it is a very important initiative for the country. And working with the Congress I think we can move this forward in a major way.

Senator WIRTH. I appreciate your being here. Thank you very much.

The CHAIRMAN. Senator Ford.

Senator FORD. Dr. Bromley, just to get back to your last statement with my good friend, Senator Wirth, about the loss of interest in math and science and computers and so forth, I was reading a study several weeks ago that shows most of the compensation for teachers and professors based on tenure but on what level of education and how long they have been teaching. If the math teacher and the PE teacher had been in the same category, they both received the same pay.

It seems to me, an effort ought to be made to encourage those entering the field that if they will teach and go back, particularly in secondary education, teach, that their salary levels will be at a higher point than those who teach physical education.

I would hope that somehow we could do that. But most states have their associations, and they have had their level—I would say in some states it is statutory, and so we need to look at that in order to turn around the decline of interest.

My friend here—you all talked about stabilization. I think you used that word. Does that not mean nuclear energy, nuclear power?

Dr. BROMLEY. It could, sir, but I believe that we have the possibility of stabilizing without massive fuel switching if we learn to use electrical energy and energy generally more efficiently than we do at the moment.

If we want to cut below the stable level and reduce our greenhouse gas output, then I believe that we have no option but to do fuel switching and that does, in my opinion, mean nuclear energy.

Senator FORD. Like I heard testimony, I believe, last year. The year before they were all opposed to nuclear energy and the next time in order to get what they want—they were for it and the next year they came in there they were opposed to it so they could get what they wanted.

And so now we are going back and using a two martini lunch called stabilization and we are going to nuclear energy. I just wanted you to know that that did not pass unnoticed.

Do you get any sleep?

Dr. BROMLEY. On occasion.

Senator FORD. Well, the reason I asked that, how many panels, commissions, committees and so forth do you head? I have been listening here now for about an hour and a half and about every other paragraph, you are heading something. I just wondered if you were overloaded.

Dr. BROMLEY. I frequently feel it, sir.

Senator FORD. I just wondered. I want to admire your stamina.

Let me read from Senator McClure's opening statement. I do not know whether he made it or not or it was just put in the record. And there is a part on the second page of his statement that says, "Last June at the Paris Symposium on Planet Earth, Frank Press, the distinguished President of the National Academy of Sciences, painted the following picture, 'Substantial reduction in carbon dioxide emissions will require a change in the economy of the world.' "

Now, do you agree with that statement?

Dr. BROMLEY. Yes. If we are going to cut back substantially on our carbon dioxide emissions, we will change much of the world's life-style.

Senator FORD. The next part of that statement, Dr. Bromley, is at a cost ranging from hundreds of billions of dollars to perhaps trillions of dollars and may not be technically feasible over the next 40 years.

Dr. BROMLEY. In that instance, sir, as I mentioned earlier, if you got the impression that our understanding of the science had many uncertainties in it, I can only tell you that the understanding of

the economics has vastly greater uncertainties and so I would find it extraordinarily difficult to give you anything in the way of an economic estimate of the cost that would be involved that would have any real meaning. We are working hard on this, but the unknowns and the variability of the input to these calculations are so great it is essentially impossible for me to respond meaningfully to what it would cost.

Senator FORD. You really do not know?

Dr. BROMLEY. I do not know, but it is going to be expensive

Senator FORD. And this will be my last one. You stated for Senator Wirth that our greenhouse gases are going down, and the rest of the world's are going up?

Dr. BROMLEY. Not going down, sir. They have essentially stopped growing at the rate they were.

Senator FORD. At least we are not growing and the rest of them are going out the top. Okay, so we are level and they are going up.

Dr. BROMLEY. Yes.

Senator FORD. I was close. We are stable, and they are going so fast it looks like we are going down. We are expected to pick up a tremendous amount of cost at the clean-up and reduction and get a hold of it. This statement I pulled out bothered me as it relates to where we are going and what we are doing, business as usual forecast it says, shows that the world will add 225 quads of consumption by the year 2010. I see you shaking your head. That is approximately right, of which the United States will add about 20. That leaves 205.

The U.S. is the most energy efficient in new applications and is only 10 percent of the growth.

Okay, we are doing very well. We have got the head shaking yes. So, one has to work on the developing countries and the Soviet Union which are more than 80 percent of the growth of our problems, yet we are saddled here and we are all talking about saving the world, and we are not even down to the 10 yard line yet.

Dr. BROMLEY. Let me say, sir, that I believe that the focus on the Third World is extraordinarily important. I believe we have an opportunity here that if we are pro-active, if we take the point of view that we should move forward to provide the Third World and Eastern Europe (where the need is certainly as great) with some of the technology that enables them to use energy more efficiently, then I think if we do it as pro-active sponsors if you will, we have three potential benefits. One, we will benefit the environment—the global environment—without question. Secondly, we have the possibility of substantial positive political fallout. Thirdly, we will gain access to a very substantial market in this technology.

If, on the other hand, we hold back until we are pushed into doing it—and I believe we will be—or we are perceived to have been pushed into it, then we will still have the same impact on the environment, but we will have lost the political good will, and we will have lost a large fraction of the market that would otherwise have been ours.

Senator FORD. Doctor, we, I guess, are not able to talk about energy policy. We have been trying for a long time, and it is getting to a point where you just almost forget it, yet we keep trying more and more to arrive at a policy, and we passed a Clean Air Act

in the Senate that hopefully will be beneficial, but we are talking roughly $20-$25 billion annually additional cost. There is not a new tax in that. We are not talking about increasing your taxes. We are just increasing your cost. So we are talking about $20-$25 billion.

I do not know what we are talking about and where we are going here. We want to change the attitude of the American people because I think it is sour as it relates to spending money.

It reminds me a little bit about the little boy who went to school, and the teacher told him he had to buy a geography book, and tell your daddy you need $3.

So he went home, discussed it with his father, he came back the next day and the teacher said do you have the money for the geography book. The little boy said no, but daddy said if you will give him a good reason, then he might give me the three dollars for buying the geography book.

The teacher said you tell your daddy if you had a geography book, you would know that two thirds of the world is water.

And the little boy went home and came back the next morning and the teacher said do you have the three dollars. He said no, and she said well, what did your daddy say when you gave him that answer. He said well, if there is that much water out there, we better make a deposit on a rowboat because this world is going to hell.

Now, we are more interested in putting the three dollars on the rowboat than we are on the geography book. And somehow or another we have got to bring people in with the decline and interest of all these things you mentioned a few moments ago. We can do everything that we possibly can do up here, but we are not going to change the attitude of the general public, and until we find that interest, we can plug and plug and plug, but somehow the grass roots are going to have to support my friend here and me and others in order to complete the job that we have.

Somehow or another we are going to have to get up every morning and stick our finger in the wind and see which way it is going so we can try to lead them. Thank you, Mr. Chairman.

Senator WIRTH. Can I ask one question?

The CHAIRMAN. First, let me mention two things. First, Dr. Bromley, in view of your comments about nuclear and the need to do R&D and demonstrate new passively safe technologies, I would invite your attention to S. 1966 which Senator McClure and I have introduced which does just that.

Secondly, on page 6 of the Committee substitute we have a statement that we should investigate the feasibility and economic energy and environmental implications of achieving a 20 percent reduction in the generation of carbon dioxide emissions by the year 2005, as recommended by the 1988 Toronto scientific world conference on the changing atmosphere.

Could that possibly be less than a good goal?

Dr. BROMLEY. Well, that is a goal that was established at Toronto. It is a goal that some 70 nations were prepared to sign on to at Noordwijk, but in all honesty, Senator, I must say that we in the United States together with the Japanese and the Soviets, who had somewhat different reasons, but were solidly with us, felt that we

did not know how we would achieve these goals and we did not know what the costs would be, and so we managed to get that requirement out of the Chairman's consensus report.

The CHAIRMAN. Well, when I say could that be possibly not a good goal, we say investigate the feasibility, not achieving the goal.

Dr. BROMLEY. That is perfectly reasonable and I think, frankly, sir, we must investigate the feasibility because we will be under enormous pressure from the countries around the world that for various reasons believe that they are prepared to sign up to that goal right now.

I must also tell you, sir, that I asked the head of one of the major European delegations at Noordwijk how they were going to achieve the goal that they seemed prepared to sign onto, and he said, "I do not know."

And I said, "Well, how can you possibly sign this", and he said, "It is only a piece of paper—they do not send you to jail if you do not do it." That is one of our problems in dealing in international fora, that other people take a somewhat different view of these documents than do we.

The CHAIRMAN. Senator Wirth.

Senator WIRTH. Thank you, Mr. Chairman. A couple of brief comments. One, on that we picked the language out of the Netherlands consensus document which is the language of the legislation, and the Netherlands document investigates the feasibility of achieving targets, and that was the language that we outlined in the bill.

Let me go back very briefly—if you want to comment on what we are doing, what the administration is doing in terms of marketing energy efficiency technology and taking advantage of the opportunities that you were describing earlier, is there an initiative going on on that front? Do you have one of Senator Ford's committees operating on that or is that a Commerce Department initiative?

Dr. BROMLEY. I cannot frankly say, sir, that there is any concrete initiative that I am aware of. We have had discussions with both the Department of Energy, and the Commerce Department, and discussions with a number of your colleagues here in the Congress on this, and it is quite clear that within the next year or so we will see some aggressive action in this area. But I cannot tell you for sure that we have such programs in hand at the moment.

Senator WIRTH. There is a title of the legislation as well that focuses on this particular issue which we thought was very important. It is subtitle H of Title III. I know you would want to look that right up as soon as you leave the room, but that is in there. We recognize the importance of doing that, and I should add to that I had a meeting yesterday morning with a number of the leading participants in the National Association of Manufacturers' panel on global climate change, and they have really moved into this in a very serious way. This is one of their major concerns.

We were talking about really pursuing this initiative. It seems to me this is one in which we ought to aggressively put together a public-private effort where we could help, you can help and the private sector can get involved in taking advantage of these opportunities.

Dr. BROMLEY. I agree with you, sir, and I think beyond that too that we in the Federal Government have a real opportunity because it is somewhat difficult to convince the public that they should make the capital investment that is required to move to the new and much more energy efficient technologies if we in the Federal Government do not do it ourselves.

And so I think that we have an opportunity in our own facilities and buildings to make the appropriate changes.

Senator WIRTH. We are trying that in the legislation as well. It is pre-scripted, to use your word, but we figured we would have to do that to tell the Federal Government we ought to do it, and it would be a lot more efficient than we are.

Mr. Chairman, I thank you very much. Dr. Bromley, you have really been a terrific witness. We look forward to working with you on this.

The CHAIRMAN. Dr. Bromley, thank you very much. You have been as Senator Wirth says, and I want to strongly echo, an excellent witness. We would like to have you back and explore this in even more depth another time.

Dr. BROMLEY. I would look forward to it, sir.

The CHAIRMAN. Thank you very much.

Next we are very pleased to welcome Linda Stuntz, who has high credibility with this Committee, at least coming into this testimony today she has high credibility. We will see how the day ends.

Seriously, Linda, thank you very much for coming. Please proceed.

STATEMENT OF LINDA G. STUNTZ, DEPUTY UNDER SECRETARY FOR POLICY, PLANNING AND ANALYSIS, DEPARTMENT OF ENERGY

Ms. STUNTZ. Thank you very much, Mr. Chairman for that warm welcome. I appreciate very much the opportunity to appear before the committee today to discuss S. 324, and I also want to commend the committee for its leadership role in the global climate change issue.

Clearly global climate change and energy are fundamentally linked. Policies to address each must also be linked. If I may submit my complete statement for the record, let me summarize it and I will try to be brief keeping in mind the hour.

Let me begin by saying the DOE shares the committee's belief that energy choices must be sensitive to environmental objectives. We also agree with you that greater energy efficiency is something that we need to pursue vigorously and aggressively.

As the committee knows, we, in conjunction with the Congress, other cabinet agencies, state and local governments and the American public are developing a national energy strategy. We are guided by the President's strong admonition that the strategy must continue the successful policy of reliance on market forces and must strike a balance among four basic public policy concerns. First, our increasing need for energy at reasonable prices;, second, our commitment to a safer and healthier environment; third, our need to maintain an economy that is second to none; and, fourth,

the reduction of dependence on potentially unreliable sources of supply for ourselves and for our allies.

The key is balance. No single policy concern should be given preeminence over the other and that, Mr. Chairman, is why we must oppose S. 324. It would elevate the achievement of a single environmental objective, reduction in the generation of carbon dioxide and greenhouse gases over all other energy and environmental objectives. As I think Dr. Bromley has just eloquently explained, our knowledge of global climate change at this point in time simply does not justify that kind of a myopic focus.

We have just published at the Department our Interim Report on the development of the national energy strategy. It is not a draft national energy strategy, but it is an important milestone in getting to a strategy which we both agree needs to be achieved.

The interim report compiles what over 400 witnesses have told us at hearings around the country and what is contained in 1,000 written submissions that we have received thus far. The interim report contains an entire chapter on global climate change and presents what the public has told us about its energy and global climate change concerns.

We, like the public, take the issue seriously. We intend to return to the public and to continue the dialogue to tap into their ideas, and move forward with efforts to narrow options and build a consensus for something that at the end of this year, we can send to the President that will be meaningful and capable of being implemented.

In addition, the Secretary has commissioned national laboratory papers to tap into the best expertise we have in our national laboratory system on four of the most important issues we see cutting across the entire energy policy spectrum. One of those issues is global climate change. Another is energy efficiency. A third issue is renewable resources, and the fourth is technology transfer. All of those we have touched on this morning. These white papers are being circulated for public comment and critical review. Once we have received public comment and conducted internal reviews, they will become a part of the information base that we will use to develop the national energy strategy.

This collaborative and open process should be compared with the least cost national energy strategy and action plan prescribed by S. 324. The proposed substitute would require energy resource acquisition targets to be set and met pursuant to a two-year action program without reference to actual market price or cost-effectiveness, but based upon an elaborate procedure for determining relative cost-effectiveness that gives "energy efficiency resources" a built-in 10 percent cost advantage over an "alternative fossil energy resource."

The Secretary has committed publicly, I think before this committee, to evaluate energy sources based on a concept of total fuel cycle costs. So, we are not totally divergent from you on this. We are interested, too, in trying to understand as best we can the costs of the total fuel cycle from production, distribution, consumption and waste treatment to the extent such wastes are relevant.

We are at work on building a modeling and a data system capable of calculating such costs, even characterizing fuel cycles, be-

cause there does not now exist consensus even as to what such fuel cycles are, let alone how much they cost.

The proposed substitute, however, assumes that we know these costs now and that these calculations should be the exclusive determinant of our nation's energy menu. The proposed substitute also unduly interferes, we think, with the President and the Secretary's management prerogatives.

As Dr. Bromley has described and as is detailed in my written testimony, we already have taken appropriate steps to assure that global climate change receives proper coordinated attention in programmatic decisions and policy debates.

The creation of new councils, new reporting requirements and the micromanagement of our research programs will only divert resources from endeavors that could materially advance our scientific understanding of global climate change or result in new, more effective responses to the threat of potential global climate change.

Now, I realize very well that the legislative branch has little sympathy for anguished executive agency cries of micromanagement. Let me suggest, however, that the research program contained in S. 324 seems to us to be a hodgepodge of disconnected pieces. Without it being placed in the context of a completed national energy strategy, it is unclear how these pieces fit into any larger plan for the optimal use of what you well know are scarce research monies as measured against all the missions of the department and the achievement of overall national policy objectives for energy, the economy, and the environment.

To point out just one example, in section 353 the Department is to oversee and certify a cadre of trained mechanics to convert gasoline and diesel powered motor vehicles to run on natural gas and LP gas, and to maintain these converted vehicles.

We, of course, are supportive of the use of alternative fuels, but why is the maintenance of a fleet of vehicles an appropriate thing for DOE or anyone else in the Federal Government to be doing? And what larger departmental mission would be served?

Mr. Chairman, we know that the committee has been considering the matter of legislative responses to global climate change for some time, and we know that there is pressure on you to do something in this area. We would point out, however, that since S. 324 was originally introduced, several parts of it have been enacted into law or have been passed by one house of Congress.

This congressional action was due to their value on general grounds, not just because of what effect they might have on global warming. Much of the renewable energy title in the original S. 324, as I am sure you are aware, became law in modified form as the Renewable Energy Efficiency Technology Competitiveness Act of 1989.

Another part of that title which concerns a research and development program on fuel cells passed the Senate as a separate bill in June of 1989 and was the subject of a March 21st hearing in the House. A title on State Energy Conservation Programs was introduced as S. 247 and passed the Senate in January of 1990. In addition, as most Senators well know, a program of clean fuels including the use of clean fuels in fleet vehicles was passed by this body

as part of the Clean Air Act amendments being considered by the House.

We would also highlight the Department's own efficiency and renewable energy initiatives, many of which bear a strong resemblance to the items in this very legislation. In January we announced a set of energy efficiency initiatives that included relighting Federal facilities, relighting commercial buildings, greater emphasis and greater support for our integrated resource planning program, accelerated building guidelines and standards, energy efficiency engineering centers, and improved end use data collection so that we can properly conduct the kind of quantitative assessments that you would like us to be able to do.

We also announced a set of renewable energy initiatives including a new partnership with Power Marketing Administrations, improving manufacturing technology for photovoltaics, developing cost-effective ethanol fuels, advancing solar detoxification of hazardous waste, establishing the Colorado National Laboratory for Renewable Energy, capturing energy from municipal waste, and expanding our hydropower contribution. We made available from currently appropriated funds some $15 million to get these started and have committed to spend, as Senator Lieberman pointed out, over $300 million on these initiatives over the next few years.

In conclusion, I think what this shows is that we are listening to what you think we ought to be doing, and we are moving forward. Our goals, objectives, and even our overall priorities do not seem to be that different. Our disagreement is on tactics, frankly, and perhaps on pace.

We ask the committee to let us finish what I believe we have well begun. Let us complete the national energy strategy. Let the IPCC, the Intergovernmental Panel on Climate Change complete its work.

With the final results of both in hand, you will be able to judge our strategy for yourselves. Then we can work together to see that it is implemented, not merely left to collect dust on the shelf as, unfortunately, too many in the past have been.

Mr. Chairman, that concludes my opening remarks, and I would be pleased to respond to your questions.

[The prepared statement of Ms. Stuntz follows:]

TESTIMONY OF LINDA G. STUNTZ

BEFORE THE

SENATE ENERGY AND NATURAL RESOURCES COMMITTEE

ON

S. 324, NATIONAL ENERGY POLICY ACT OF 1990

APRIL 5, 1990

Thank you Mr. Chairman for the opportunity to present the Department of Energy's views on a proposed substitute to S. 324. DOE shares the committee's belief that our energy choices must be sensitive to environmental objectives. We appreciate the opportunity to work with the committee to promote policies that harness market forces to sustain economic productivity, stimulate technology innovation and improve environmental quality. Unfortunately, the proposed substitute to S. 324 does not, on balance, embody energy policy that achieves these objectives. The Administration strongly opposes its enactment.

We begin our analysis of S. 324 from the premise that what we do **not** know about human activity-induced global climate change far exceeds what we **do** know.

Recently published results of scientific research show considerable uncertainty on the extent of global climate change and the potential impact thereof. I defer to Dr. Bromley to discuss the state of the science.

Given this level of uncertainty about global climate change, we should continue the aggressive research program being supported by various Federal agencies, including DOE, to understand more fully the ramifications of global climate change. In the meantime, we should embark on measures to reduce greenhouse gas emissions only if those measures also serve other policy objectives. That is precisely what the Administration has done.

DEPARTMENT OF ENERGY RECENT INITIATIVES

We have previously discussed with this Committee our efforts to develop a National Energy Strategy (NES), and the central role that the potential for global climate change will play in that strategy. The Secretary has just released an Interim Report which is a compilation of the extensive public consultations that we have undertaken during the last nine months.

Global climate change issues were a major topic during the initial round of NES hearings. In subsequent hearings in Atlanta co-chaired by Environmental Protection Agency Administrator Reilly and in Washington, D.C. co-chaired by Dr. Bromley, entire panels representing various views were devoted to global climate change concerns and the appropriate energy policy response. The chapter on global environmental issues in the Interim Report is

based on this public hearing testimony and on written submissions.

The Secretary also has had the National laboratories prepare several analytical papers to address certain energy and environmental issues. These analyses of efficiency and renewable energy potential, of technology transfer, and of global climate change science provide useful points of reference for the issues we are discussing here today. The information contained in these reports will be further analyzed by the Department along with the NES public record, and additional new studies to be undertaken in the coming months in order to address, in a deliberate and comprehensive manner, most of the issues contained in S. 324.

In addition to the NES development process, DOE has taken several actions, for other purposes, but which also will reduce greenhouse gas emissions.

- In November 1989 a more stringent efficiency standard for refrigerators and freezers was promulgated. Under certain circumstances it is estimated that the efficiency gain could save consumers nearly $20 a year, on average, in electricity costs. It also will reduce

energy use, and hence, projected greenhouse gas emissions.

- Additionally, a series of conservation and renewable initiatives was announced on January 26th. This package of measures has the potential, when fully implemented, to substantially reduce projected CO_2 emissions.

- The most recent Clean Coal Technology solicitation (CCT-3) contained evaluation criteria that credited efficiency increases. The CCT-4 solicitation currently being drafted is expected to focus on high efficiency systems and provide extra credits to proposals that address CO_2 reduction.

- The Department is placing two contracts, with Westinghouse and General Electric, to continue development of two advanced midsize simplified nuclear power plants that achieve safety through natural or passive systems. These reactors are expected to receive certification by NRC as standardized nuclear plant designs by 1995 and could be utilized thereafter

to generate electricity without greenhouse gas emissions.

DOE's Office of Energy Research has recently begun two major research efforts aimed at addressing key weaknesses in our understanding of global climate change. The first, called the Atmospheric Radiation Measurement (ARM) program, will improve our global estimates of radiation reaching the earth's surface. This is especially important for determining the role of clouds in climate change. The second initiative, entitled Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP) Program, is directed at developing the next generation of climate models. This effort will take advantage of state-of-the-art computing methods and hardware to build an advanced climate model which can more effectively address regional scale climate issues. An initial phase of this program attempts to determine the feasibility of improved prediction and to determine what can realistically be expected from such predictions. The DOE budget request for global climate change research in FY 1991 is $66 million, up from $17 in FY 1989.

- DOE has been very active in the working groups and subgroups of the Intergovernmental Panel on Climate Change. As examples,

    - DOE staff are among the authors of the Working Group 2 Report on Impacts of Climate Change that is currently in preparation,

    - DOE has played a major role within the U.S. Goveinment for the Energy and Industry Subgroup Report to the Response Strategies Working Group (RSWG), and

    - DOE is one of several domestic agencies supporting the Department of State's leadership efforts in the Response Strategies Working Group.

- Lastly, DOE has recently organized its global climate change related activities to better respond to the analytical and policy development needs of this rapidly moving issue. (See attached Secretary of Energy Notice). The Secretary has assigned leadership for DOE's policy development activities on climate change

to the Office of Policy, Planning and Analysis (PE) and to the Office of International Affairs (IE). PE will have the lead in conducting analysis of climate change response strategies and in policy development. IE will coordinate DOE's representational responsibilities in international fora. The Office of Energy Research continues to lead our atmospheric research program. An Assistant Secretary level Global Climate Change Executive Committee (GCCEC) and a supporting staff level group that includes all relevant DOE elements have been organized to coordinate DOE activities on climate change. The Deputy Under Secretary for Policy Planning and Analysis and the Assistant Secretary for International Affairs jointly chair this group.

The core of DOE's response to the risks associated with greenhouse gas emissions is its technology development programs. All technology program offices are actively involved in the GCCEC and are re-evaluating their R&D programs in light of the potential for climate change. The National Academy of Engineering is conducting an assessment of Federal energy technology R&D activities, in the light of potential global climate change, as part of a Congressionally-mandated study required by the FY 89 Energy and Water Appropriations bill. The

NAE study, DOE's ongoing re-assessments of programmatic priorities, and the substantial effort being devoted to the National Energy Strategy, will provide the tools necessary for the Secretary to make any needed improvements in the technology R&D program.

INITIATIVES OF THE EXECUTIVE BRANCH

Three key Administration initiatives will also contribute to future reductions in greenhouse gas emissions.

- The Federal government has requested a global climate change research budget in FY 1991 of $1.034 billion, a 57 percent increase over FY 1990. The U.S. Global Climate Change Research Program is by far the largest such program in the world.

- The President's proposed Clean Air Act Amendments, in addition to addressing acid rain and other air quality issues, also would reduce greenhouse gas emissions by encouraging increased end-use energy efficiency, and higher efficiency in use of fossil fuels.

- In his State of the Union address, the President announced a program to plant over one billion new trees

per year. Over the lifetime of one billion new trees, they will annually sequester about 13 million tons of carbon per year. Continuation of a tree planting program of this scale for a 20 year period would sequester more than 5 percent of U.S. emissions for 1987. This effort to increase CO_2 "sinks" combined with the President's commitment to phase-out CFCs by the year 2000, subject to the availability of safe substitutes, means that a significant reduction in greenhouse forcing gases will occur.

These activities are Administration responses to potential global climate change that have come to the forefront since the Department provided earlier comments on S. 324. It should be clear that our response is not limited to improving science over a multi-year time frame, although improving our understanding of the process of global climate change is and must continue to be a top priority. The Administration's response also includes specific actions which will have the effect of reducing greenhouse gas emissions. Those actions, however, serve other policy objectives and thus make sense, even if the potential for human-induced global climate change does not turn out to be as much of a concern as some have postulated.

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